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ABSTRACT

The goal of this mini-unit is to involve students and their parents in a cooperative exercise to increase awareness of areas of household energy consumption. Low-cost methods for reducing energy waste and reducing energy costs are provided. The document has separate sections containing activities in the disciplines of: (1) home economics, (2) mathematics, (3) science, and (4) social studies. (Author/RE)

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Accounting for Household Energy Consumption

A Teacher's Guide for the Classroom Implementation
of Colorado's Energy Scorecard

Do Not Film This Page

COLORADO OFFICE OF ENERGY CONSERVATION

Buie Seawell, Director

Robert P. Brown, Director,
Colorado Energy Extension Service

October, 1979

Prepared for the Colorado Office of Energy Conservation

By: Charles A. Bottinelli
Energy Information Associates, Inc.
2690 West Main Street
Littleton, Colorado 80120

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FOREWORD

During past crises, society has turned toward educators for help in changing attitudes, in preparing students for new roles in the work force and in adapting to new ethics and behaviors consistent with changing societal goals, needs and policies.

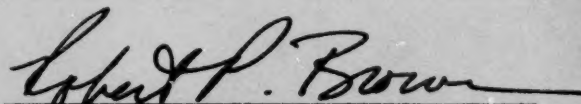
The worldwide energy dilemma demands that greater emphasis be placed upon awareness and understanding of energy fundamentals as they relate to all facets of our lives. Sporadic and severe local shortages of energy fuels have brought general recognition that our reserves of petroleum and natural gas, the two fossil fuels upon which we rely for over three-fourths of our energy needs, are, indeed, exhaustible - and within the lifetimes of today's students. More important, the relationships among energy, economics, agriculture, transportation and utility costs have become most vivid to many Americans.

Exacerbating the dilemma are the demands of life styles resulting from increasing technological achievements and gross inefficiencies in our management of energy.

The crisis in fossil energy fuel reserves and sky-rocketing utility costs affect the lives and activities of all peoples; hence, the importance of the role of schools in teaching a new energy conservation ethic: We must use energy more efficiently and with less waste in our factories, in our schools and businesses, and in our homes.

To assist teachers in the education of junior high students in the area of household energy consumption and conservation, this multi-disciplinary mini-unit has been prepared for use in conjunction with

Colorado's residential energy audit, The Energy Scorecard. It is our hope that teachers will use the unit as a starting point, perhaps integrating them into a more comprehensive energy education program. A broad effort in energy conservation education is needed to aid society in dealing with this urgent problem.



Robert P. Brown
Director of Community Programs
Colorado Office of Energy Conservation

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INTRODUCTION

At no other time in the history of the U.S. Industrial Revolution has there been a greater need for a national commitment to conserving fossil energy fuel reserves and to make a transition to more renewable sources of energy. Transitions to other fuels have occurred in the past - from wood to coal, from coal to petroleum and natural gas. The difference is that now, realizing that our petroleum and natural gas reserves are in danger of depletion within our lifetimes, due to escalating demand, society must make a transition to more sustainable sources; whereas previous transitions were voluntary, and spurred by inventions and general technological advancements.

Paralleling the growing scarcity of fuel reserves are the increasing costs we must pay for them. According to Public Service Company of Colorado, during 1971-1977 the costs of natural gas and electricity increased approximately 137% and 44%, respectively. Should these rates of exponential increase continue, a Colorado citizen who now pays \$50 for gas and \$50 for electricity per month can expect to pay \$133 for gas and \$68.50 for electricity in October of 1983. By October, 1988, this consumer would be paying \$355 and \$94 for gas and electricity, respectively. There is little doubt that increasing energy costs will cut increasingly into family budgets in the future, affecting all our lifestyles but, especially, the lives of today's students who will be tomorrow's adults.

The teacher's responsibility is a critical one in preparing students to live in the new energy era. Changing time honored and tradition-enshrined attitudes and behaviors is a prerequisite in adapting to a new energy ethic and essential in working toward solutions.

This material is intended to give Colorado teachers assistance and suggestions for implementing Colorado's Energy Scorecard in their classrooms. Although the Scorecard can be an effective learning strategy in and of itself, the support activities and background information which enhance the Scorecard will allow the teacher to spend one week (or more) in instruction related to household energy consumption and conservation. The goal of this "mini-unit" is to involve students and their parents in a cooperative exercise which will provide an awareness of areas of household energy consumption and low-cost methods to trim energy waste - and to save money.

The U.S. Energy Dilemma

Diagnosing this country's energy dilemma is simple. Our demand for energy has been increasing exponentially at a rate of nearly 3% annually while, at the same time, our precious reserves of petroleum and natural gas are diminishing -- just as steadily.

Our situation has been compared to a high-speed passenger train and an inevitable collision with an obstruction on the tracks just around the bend. While only a few crew members and passengers are aware of impending disaster, most continue with "business as usual", and no concerted attempt has been made to slow the train. Although the collision is inevitable, the extent of the disaster will be related directly to the speed of the train.

The Department of Energy, in The National Energy Plan, has stated: "Unless the U.S. makes a timely adjustment before world oil becomes very scarce and very expensive in the 1980's, the nation's economic security and the American way of life will be gravely endangered. The steps the U.S. must take now are small compared to the drastic measures that will



be needed if the U.S. does nothing until it is too late.

How Could It Happen to Us?

In retrospect, it is clear how the energy problem evolved. During the decades of the 1950's and 1960's, we built a fantastically enormous stock of capital goods - heavy, powerful, luxurious cars, spacious, uninsulated homes, factories and equipment - all of which use energy very inefficiently. Simultaneously, these two decades witnessed a decline of 28% in the real price of energy; as a result, U.S. energy consumption increased exponentially at 3.5%/year, doubling at the close of the 60's.

Then, world oil prices quadrupled in 1973-74. They have been escalating almost regularly since.

Now, we are blessed with the legacy of our productivity of the 50's and 60's, at a time when we must make a transition to a more renewable, more sustainable energy fuel base. The fact is that we have entered a new energy era - an era characterized by dwindling production of petroleum and natural gas, extremely high prices for imported oil and synthetic substitutes and economic/environmental ramifications ranging from massive unemployment to major ecosystem disruption.

Consumption of our two "reliables", petroleum and natural gas, cannot continue to grow at the rates to which most Americans have been accustomed. Further, the remaining reserves must be guarded judiciously as important chemical feedstocks. It is reasonable to expect that adjustments to the requirements of this new era will not be easy and will, in fact, reshape the United States during the remainder of this century.

Energy Use by Sector

How do we use energy? Figure 2 shows total energy use by sector.

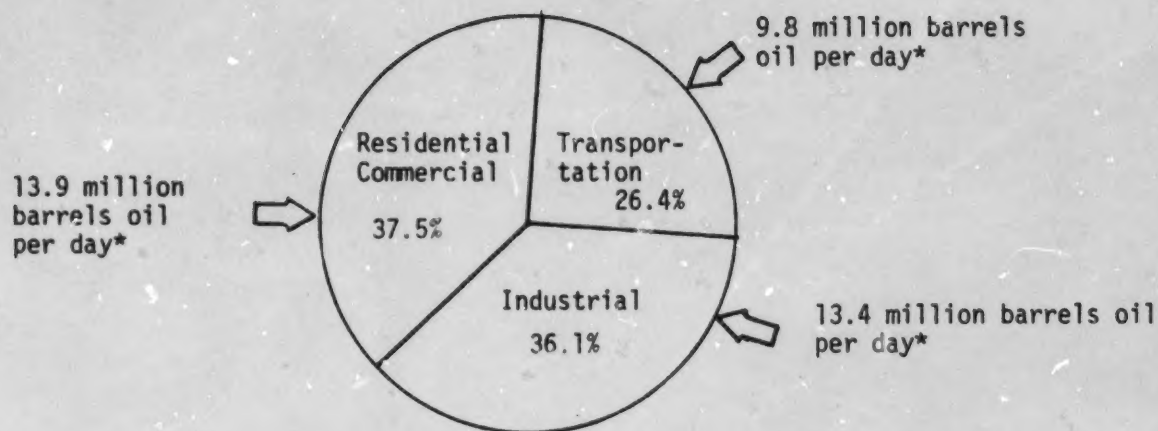


Fig. 2. Total U.S. Energy Use by Sector, 1978

If fuel type is broken out of each sector in Figure 2, it can be seen how much of what source of energy each sector consumes. (Fig. 3,4,5)

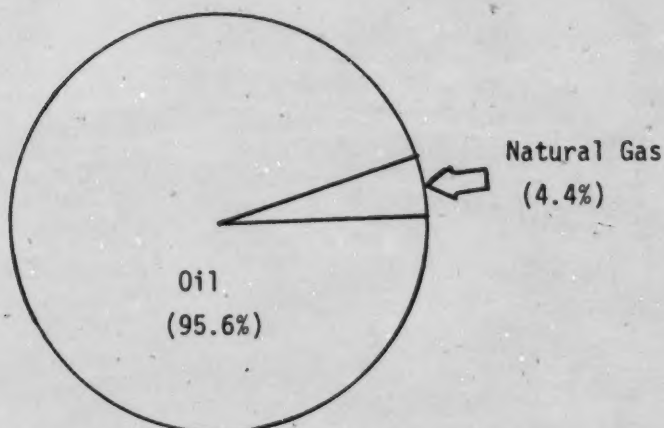


Fig. 3. Transportation

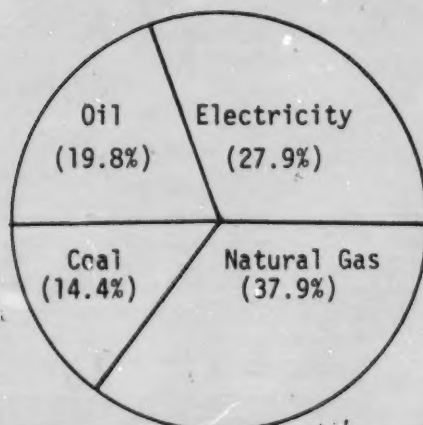


Fig. 4. Industry

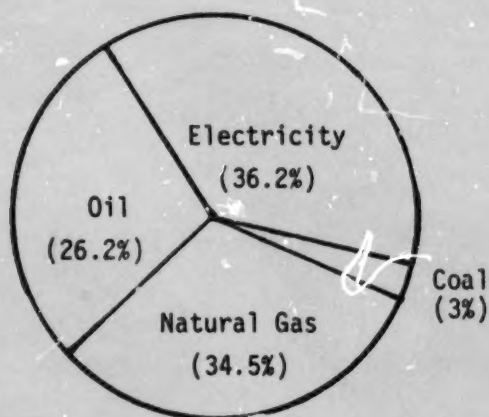


Fig. 5. Residential/Commercial

Much is said about the importance of energy conservation these days. As citizens, how can we best do our share to conserve energy fuels? By helping to reduce energy consumption in and around our homes and businesses, we can make a dent in the residential/commercial and transportation sectors, two large chunks accounting for more than 60% of the total energy consumption of this country. But in what areas of household energy use can we make the greatest impact, saving energy and money? Figure 6 shows 1978 residential energy consumption by general end use.

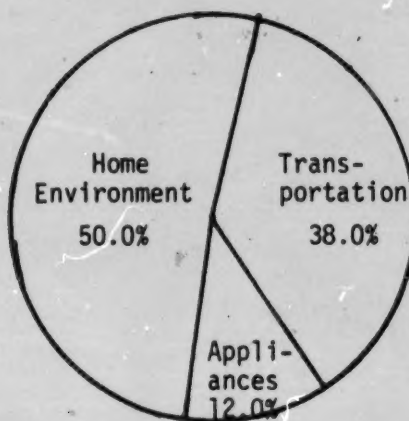


Fig. 6. 1978 Residential Energy Consumption by General End Use

It is clear that reductions in the areas of Home Environment and Transportation may have the greatest impact, and may be effected most easily by families themselves. But what specific end uses are included in each of these three areas?

Home Environment includes such end uses as: space heating and cooling systems, water heating, air infiltration, and ventilation. Appliances includes cooking equipment, lighting, refrigeration and the countless other labor-saving devices we all have in our homes. Transportation involves the family automobiles, motorcycles, public transit, air travel and community/shopping habits.

The following section, The Energy Scorecard, describes how students and parents can conduct a thorough inventory of household energy consumption and how energy waste can be curbed.

The Energy Scorecard

How To Use It

The Energy in Your Life

The Energy Scorecard lets you take a look at how you use energy in three major areas: Transportation, the Home and Appliances. There also is a special section on Energy Alternatives where you can receive credit on your energy score if you use solar energy, wind or some other alternative energy source.

A suggestion: spend several evenings with The Energy Scorecard. Do Transportation one day, Home the next, and so on. It takes an hour or two to complete The Energy Scorecard. Make it a family project.

Energy Points

Determine your energy score with Energy Points. Each of the three major energy use areas (Transportation, Home, Appliances) are split into energy spending and energy savings sections. In each spending section, you count up your ENERGY SPENDING POINTS based on how you have used energy in the past year. Use the circles to keep track of your scores. In each savings section, and in the section on Energy Alternatives, add up ENERGY SAVINGS POINTS based on energy conservation steps you already have taken or will definitely take in the next three months. Use the squares to keep track of your scores.

Summaries and Net Energy Score

Each section has a summary area at the end to total up your score for the section and let you see how you compare with the average Colorado energy user. Also, at the end of each energy savings section, you can figure out your Net Energy Score by subtracting your ENERGY SAVINGS POINTS from your ENERGY SPENDING POINTS. That tells you what your energy score is (or would be) after you take energy conservation into account.

Summing Up and The Energy Scoreboard

The "Summing Up" section on page 16 lets you add up your energy spending and energy savings scores from the major sections in The Energy Scorecard and determine your overall Net Energy Score.

Mark your overall Energy Spending Score on the first column of "The Energy Scoreboard" on page 16 and your Net Energy Score in the second column. The other columns on The Energy Scoreboard show the average energy consumption of people or families living in Colorado, the United States, Western Europe and the World. Compare your score with theirs.

The Buck Stops Here (the BTU too!)

To convert your point scores to dollars, use these factors: Transportation points are worth \$2.50 each; Home points are worth \$1.00 each if you heat with natural gas or \$1.75 each if you heat with electricity; Appliance points are worth \$1.75 each. These are based on Colorado averages.

Each energy point, by the way, equals 440,000 BTU, or British thermal units (a measurement of energy). A BTU equals the amount of heat given by one match. The scoring system is based on 1,000 points equalling 440 million BTUs, the average energy consumption in a typical Colorado household, including transportation, for one year.

Energynotes

These features, sprinkled through The Energy Scorecard, provide some additional information on how energy is used and saved.

Apartment and Mobile Home Dwellers

The Energy Scorecard admittedly is geared toward a single-family dwelling, but you can use it too. The Transportation and Appliance sections apply equally to all people, regardless of where they live. Do the best you can with the home energy sections. There is a special section for mobile home dwellers in the Spending Home Energy section. And Table 2 of the same section includes point scores for apartments.

Your Energy Dollar



Here's where it all goes:

Auto Travel	34¢
Bus, Train, Air Travel	4¢
Home Heating/Cooling	41¢
Hot Water	9¢
Appliances/Lighting	12¢

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The Colorado Office of Energy Conservation was created August 16, 1977, by executive order of the Governor. The agency is administering and implementing the Colorado Energy Conservation Plan, which was developed by a broad range of Colorado citizens. The goal of the state's plan is to reduce the entire state energy consumption by more than 8 percent by 1990. Funds for the production of The Energy Scorecard were provided by a grant from the U. S. Department of Energy.

A Message From The Governor

Colorado is a state with a heritage of living conservatively. The first settlers of this state learned well how to live with the limited amounts of water available in our environment. Today we continue this conservation ethic in the use of all our resources. Waste is not a part of the heritage which made us what we are.

In a time of a world wide concern about the rising cost and available supply of energy for home use, business, and transportation, Colorado has a unique responsibility. We must continue to be an example to the rest of the nation of the virtue of conserving our irreplaceable resources.

The Energy Scorecard is a simple and effective way for every person in Colorado to take stock of how he or she uses energy, and more importantly how that energy can be conserved. I urge you to participate in this effort. It can save you money. It can also continue Colorado's leadership role in energy for our nation.

Sincerely,

Richard D. Lamm

Richard D. Lamm
Governor

A MESSAGE FROM THE DIRECTOR OF THE COLORADO OFFICE OF ENERGY CONSERVATION

Your utility bills are probably higher now than they've ever been. Costs at the gas pump are up dramatically. Energy prices in general are rising.

There are ways to curb those rising energy costs. The Colorado Office of Energy Conservation would like to help you help yourself in this important area.

The Energy Scorecard offers a way to identify how much energy you spend and how much you can save. You can score your own energy habits with The Energy Scorecard and take a look at ways to cut energy use in some areas.

The information we used is based on current research and construction practices. It is not our intention to endorse any particular product or service, but merely to give you ideas about how you can save energy and money. There may be items we overlooked. The Energy Scorecard is based on averages and estimates.

Energy conservation has to start with each and every resident of our state and nation. By taking the directions and actions pointed out in The Energy Scorecard, you are on the way to major energy and dollar savings.

Good Luck!

Sincerely,

M. Sue Seawell

M. Sue Seawell

Spending Transportation Energy

You spend about 38 cents out of each energy dollar on transportation. In this first section of The Energy Scorecard you can assess ENERGY SPENDING POINTS based on how you and your family used transportation energy in the past year. After you've done that, the next section will show you how to trim some of these transportation energy costs.

Automobile

Table 1 will help you determine your ENERGY SPENDING POINTS for each automobile you own. Find the number of miles driven over the year in the leftmost column and read across the table until you hit the column corresponding to the average miles per gallon for your car. Use the table for motorcycles, campers and trucks as well. For example, if you drove your car 15,000 miles and got 11 miles per gallon, you'd score 360 ENERGY SPENDING POINTS. If you don't know these figures for your car assume the averages of 15 miles per gallon and 12,000 miles per year. Remember, score each vehicle you own separately and enter the total in the appropriate scoring circle.

TABLE 1

TABLE 1				MILES PER GALLON																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
				5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81	83	85	87	89	91	93	95	97	99	101	103	105	107	109	111	113	115	117	119	121	123	125	127	129	131	133	135	137	139	141	143	145	147	149	151	153	155	157	159	161	163	165	167	169	171	173	175	177	179	181	183	185	187	189	191	193	195	197	199	201	203	205	207	209	211	213	215	217	219	221	223	225	227	229	231	233	235	237	239	241	243	245	247	249	251	253	255	257	259	261	263	265	267	269	271	273	275	277	279	281	283	285	287	289	291	293	295	297	299	301	303	305	307	309	311	313	315	317	319	321	323	325	327	329	331	333	335	337	339	341	343	345	347	349	351	353	355	357	359	361	363	365	367	369	371	373	375	377	379	381	383	385	387	389	391	393	395	397	399	401	403	405	407	409	411	413	415	417	419	421	423	425	427	429	431	433	435	437	439	441	443	445	447	449	451	453	455	457	459	461	463	465	467	469	471	473	475	477	479	481	483	485	487	489	491	493	495	497	499	501	503	505	507	509	511	513	515	517	519	521	523	525	527	529	531	533	535	537	539	541	543	545	547	549	551	553	555	557	559	561	563	565	567	569	571	573	575	577	579	581	583	585	587	589	591	593	595	597	599	601	603	605	607	609	611	613	615	617	619	621	623	625	627	629	631	633	635	637	639	641	643	645	647	649	651	653	655	657	659	661	663	665	667	669	671	673	675	677	679	681	683	685	687	689	691	693	695	697	699	701	703	705	707	709	711	713	715	717	719	721	723	725	727	729	731	733	735	737	739	741	743	745	747	749	751	753	755	757	759	761	763	765	767	769	771	773	775	777	779	781	783	785	787	789	791	793	795	797	799	801	803	805	807	809	811	813	815	817	819	821	823	825	827	829	831	833	835	837	839	841	843	845	847	849	851	853	855	857	859	861	863	865	867	869	871	873	875	877	879	881	883	885	887	889	891	893	895	897	899	901	903	905	907	909	911	913	915	917	919	921	923	925	927	929	931	933	935	937	939	941	943	945	947	949	951	953	955	957	959	961	963	965	967	969	971	973	975	977	979	981	983	985	987	989	991	993	995	997	999	1001	1003	1005	1007	1009	1011	1013	1015	1017	1019	1021	1023	1025	1027	1029	1031	1033	1035	1037	1039	1041	1043	1045	1047	1049	1051	1053	1055	1057	1059	1061	1063	1065	1067	1069	1071	1073	1075	1077	1079	1081	1083	1085	1087	1089	1091	1093	1095	1097	1099	1101	1103	1105	1107	1109	1111	1113	1115	1117	1119	1121	1123	1125	1127	1129	1131	1133	1135	1137	1139	1141	1143	1145	1147	1149	1151	1153	1155	1157	1159	1161	1163	1165	1167	1169	1171	1173	1175	1177	1179	1181	1183	1185	1187	1189	1191	1193	1195	1197	1199	1201	1203	1205	1207	1209	1211	1213	1215	1217	1219	1221	1223	1225	1227	1229	1231	1233	1235	1237	1239	1241	1243	1245	1247	1249	1251	1253	1255	1257	1259	1261	1263	1265	1267	1269	1271	1273	1275	1277	1279	1281	1283	1285	1287	1289	1291	1293	1295	1297	1299	1301	1303	1305	1307	1309	1311	1313	1315	1317	1319	1321	1323	1325	1327	1329	1331	1333	1335	1337	1339	1341	1343	1345	1347	1349	1351	1353	1355	1357	1359	1361	1363	1365	1367	1369	1371	1373	1375	1377	1379	1381	1383	1385	1387	1389	1391	1393	1395	1397	1399	1401	1403	1405	1407	1409	1411	1413	1415	1417	1419	1421	1423	1425	1427	1429	1431	1433	1435	1437	1439	1441	1443	1445	1447	1449	1451	1453	1455	1457	1459	1461	1463	1465	1467	1469	1471	1473	1475	1477	1479	1481	1483	1485	1487	1489	1491	1493	1495	1497	1499	1501	1503	1505	1507	1509	1511	1513	1515	1517	1519	1521	1523	1525	1527	1529	1531	1533	1535	1537	1539	1541	1543	1545	1547	1549	1551	1553	1555	1557	1559	1561	1563	1565	1567	1569	1571	1573	1575	1577	1579	1581	1583	1585	1587	1589	1591	1593	1595	1597	1599	1601	1603	1605	1607	1609	1611	1613	1615	1617	1619	1621	1623	1625	1627	1629	1631	1633	1635	1637	1639	1641	1643	1645	1647	1649	1651	1653	1655	1657	1659	1661	1663	1665	1667	1669	1671	1673	1675	1677	1679	1681	1683	1685	1687	1689	1691	1693	1695	1697	1699	1701	1703	1705	1707	1709	1711	1713	1715	1717	1719	1721	1723	1725	1727	1729	1731	1733	1735	1737	1739	1741	1743	1745	1747	1749	1751	1753	1755	1757	1759	1761	1763	1765	1767	1769	1771	1773	1775	1777	1779	1781	1783	1785	1787	1789	1791	1793	1795	1797	1799	1801	1803	1805	1807	1809	1811	1813	1815	1817	1819	1821	1823	1825	1827	1829	1831	1833	1835	1837	1839	1841	1843	1845	1847	1849	1851	1853	1855	1857	1859	1861	1863	1865	1867	1869	1871	1873	1875	1877	1879	1881	1883	1885	1887	1889	1891	1893	1895	1897	1899	1901	1903	1905	1907	1909	1911	1913	1915	1917	1919	1921	1923	1925	1927	1929	1931	1933	1935	1937	1939	1941	1943	1945	1947	1949	1951	1953	1955	1957	1959	1961	1963	1965	1967	1969	1971	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995	1997	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017	2019	2021	2023	2025	2027	2029	2031	2033	2035	2037	2039	2041	2043	2045	2047	2049	2051	2053	2055	2057	2059	2061	2063	2065	2067	2069	2071	2073	2075	2077	2079	2081	2083	2085	2087	2089	2091	2093	2095	2097	2099	2101	2103	2105	2107	2109	2111	2113	2115	2117	2119	2121	2123	2125	2127	2129	2131	2133	2135	2137	2139	2141	2143	2145	2147	2149	2151	2153	2155	2157	2159	2161	2163	2165	2167	2169	2171	2173	2175	2177	2179	2181	2183	2185	2187	2189	2191	2193	2195	2197	2199	2201	2203	2205	2207	2209	2211	2213	2215	2217	2219	2221	2223	2225	2227	2229	2231	2233	2235	2237	2239	2241	2243	2245	2247	2249	2251	2253	2255	2257	2259	2261	2263	2265	2267	2269	2271	2273	2275	2277	2279	2281	2283	2285	2287	2289	2291	2293	2295	2297	2299	2301	2303	2305	2307	2309	2311	2313	2315	2317	2319	2321	2323	2325	2327	2329	2331	2333	2335	2337	2339	2341	2343	2345	2347	2349	2351	2353	2355	2357	2359	2361	2363	2365	2367	2369	2371	2373	2375	2377	2379	2381	2383	2385	2387	2389	2391	2393	2395	2397	2399	2401	2403	2405	2407	2409	2411	2413	2415	2417	2419	2421	2423	2425	2427	2429	2431	2433	2435	2437	2439	2441	2443	2445	2447	2449	2451	2453	2455	2457	2459	2461	2463	2465	2467	2469	2471	2473	2475	2477	2479	2481	2483	2485	2487	2489	2491	2493	2495	2497	2499	2501	2503	2505	2507	2509	2511	2513	2515	2517	2519	2521	2523	2525	2527	2529	2531	2533	2535	2537	2539	2541	2543	2545	2547	2549	2551	2553	2555	2557	2559	2561	2563	2565	2567	2569	2571	2573	2575	2577	2579	2581	2583	2585	2587	2589	2591	2593	2595	2597	2599	2601	2603	2605	2607	2609	2611	2613	2615	2617	2619	2621	2623	2625	2627	2629	2631	2633	2635	2637	2639	2641	2643	2645	2647	2649	2651	2653	2655	2657	2659	2661	2663	2665	2667	2669	2671	2673	2675	2677	2679	2681	2683	2685	2687	2689	2691	2693	2695	2697	2699	2701	2703	2705	2707	2709	2711	2713	2715	2717	2719	2721	2723	2725	2727	2729	2731	2733	2735	2737	2739	2741	2743	2745	2747	2749	2751	2753	2755	2757	2759	2761	2763	2765	2767	2769	2771	2773	2775	2777	2779	2781	2783	2785	2787	2789	2791	2793	2795	2797	2799	2801	2803	2805	2807	2809	2811	2813	2815	2817	2819	2821	2823	2825	2827	2829	2831	2833	2835	2837	2839	2841	2843	2845	2847	2849	2851	2853	2855	2857	2859	2861	2863	2865	2867	28

Your Transportation Energy Spending

Automobile
Motorcycle
Moped·Minibike
Air Travel
Bus·Train
Public Transit



Your Total
Score



What Your Score Means

Score 1-3: You are spending a lot of money on transportation energy. But there are many ways to save money and energy in transportation.

Score 4-6: You are spending a moderate amount of money on transportation energy. But there are still many ways to save money and energy in transportation.

Score 7-9: You are spending a small amount of money on transportation energy. But there are still many ways to save money and energy in transportation.

Saving Transportation Energy

You already may be saving transportation energy by using public transit or in other ways. This section of The Energy Scorecard will help you count up **ENERGY SAVINGS POINTS** as you learn a little about saving money and energy in transportation.

One way to save money and energy in transportation is to reduce the number of miles you drive. That's easy if you live in a city with bus service and car pools for regular commuting. It's a tougher task in the country or in smaller cities. But there are ways to cut back in rural areas too. Plan shopping trips to avoid unnecessary travel. And for shorter trips, consider walking or bicycling.

Take a look at these energy saving ideas and give yourself **ENERGY SAVINGS POINTS** for those steps you will take in the next three months.

Remember, these point scores are for each family member. If two of you take one of these steps, you get twice as many points.

Carpooling

If you switch from driving to work or school by yourself to a carpool, record 41 points if there are 2 persons per car, 55 points for 3 per car, or 66 points for 4 per car.

ENERGY SAVINGS POINTS
CARPOOLING

☐

Vanpooling

Vanpooling is simply using a van instead of a car to get a group of people to work and back. If you switch from driving alone to a vanpool with 3 persons per van, record 57 points.

ENERGY SAVINGS POINTS
VANPOOLING

☐


Motorcycle

Switch from a car to a motorcycle for regular commuting and record 62 points.

ENERGY SAVINGS POINTS
MOTORCYCLE

☐


The Bus

If you get out of your car and get on the bus for daily commuting to work or school, record 63 points.

ENERGY SAVINGS POINTS
THE BUS

☐

Shopping Trips

If you've cut shopping trips to one a week, or will do so in the next three months, record 23 points.

ENERGY SAVINGS POINTS
SHOPPING TRIPS

☐

Energynote

Pool II

Several metropolitan areas in Colorado offer carpool and vanpooling services. Here's some phone numbers for those services now available.

Biking • Walking

In addition to the beneficial exercise you'll get by switching from the car to a bicycle or walking for daily commuting, you also get 32 points.

ENERGY SAVINGS POINTS
BIKING/WALKING

☐

Long Trips

Record 25 points for each time a family member could take a long trip in the next year on a bus or train instead of an airplane. Make a reasonable guess.

ENERGY SAVINGS POINTS
LONG TRIPS

☐

Moped • Minibike



Commuting on one of these popular new machines instead of in your car is worth 72 points.

ENERGY SAVINGS POINTS
MOPED/MINIBIKE

☐

Auto Maintenance and Operation



Keeping your car in top running order saves you energy and money. Record the appropriate ENERGY SAVINGS POINTS for each of the following practices if you do them, or plan to begin doing them:

Regular tune-ups, filter changes and lubrication. 17 points.

Switch from bias to radial tires with proper inflation. 21 points.

Drive more energy efficiently. Accelerate slowly. Coast to a stop. Drive between 35 and 50 miles per hour. Shift to high gears quickly. 29 points.

Switch to a more efficient car. Or cut back on the miles driven. In either case, use Table 1 and refigure your score. Record the difference as ENERGY SAVINGS POINTS. (Example: Old car points = 284; new car points = 202; ENERGY SAVINGS POINTS = 284 - 202 = 82.)

ENERGY SAVINGS POINTS
AUTO MAINTENANCE AND
OPERATION

☐

Your Transportation Energy Savings

Carpooling
Vanpooling
Shopping Trips
The Bus
Biking • Walking
Moped • Minibike
Motorcycle
Long Trips
Auto Maintenance • Operation

Your Total Score

☐

How are you doing?

Old Score - New Score = Net Energy Savings

Old Score

☐

Net Score

Net Energy Savings

Spending Home Energy



Heating and cooling the home, and providing hot water consume nearly half the energy we use. The amount of energy you use around the home and the amount of money you spend on utility bills depend on three things:

- How well your home holds heated or cooled air. That means insulation, storm windows, storm doors and good caulking and weatherstripping.
- How well your heating and cooling systems work. Your furnace cooling equipment and hot water heater must be maintained properly to operate efficiently.
- Your lifestyle. You control the amount of energy used in your home. You can make a significant cut in utility bills just by turning down the thermostats on your furnace and hot water heater, and by paying attention to doors, windows and light switches.

In this section of The Energy Scorecard, add up ENERGY SPENDING POINTS based on how you and your family used energy in your home during the past year.

Warming Up

Here's what you need to do to determine your ENERGY SPENDING POINTS for keeping your home warm:

First, Either measure your heated floor space or just count the rooms in your home, excluding bathrooms. Note whether your home falls into the Small, Medium or Large category in Table 2. The categories are used on other tables in The Energy Scorecard.

Second, Decide whether your home has excellent, good, poor or no insulation. This is your insulation grade for use in Table 2. The Energynote called "The Energy Blanket INSULATION" can help you figure out how much insulation you have.

Third, Use Table 2 to determine your ENERGY SPENDING POINTS for Warming Up. **Subtract** up your house also with insulation grade and type of furnace. **MAKE SURE YOU SUBTRACT THE PROPER NUMBER OF POINTS IF YOU HAVE STORM WINDOWS / DOORS AND CAULKING / WEATHERSTRIPPING SO YOU GET AN ACCURATE POINT SCORE BASED ON ACTUAL HOME HEATING NEEDS.** Example: You heat your six room home with natural gas and have "Good" insulation (none in walls, R-19 in ceiling). Your score from table 2 is 423 ENERGY SPENDING POINTS. If you had good caulking and weatherstripping, your score would be 388 (423 - 34 = 388).

Fourth, If you live above 5,000 feet, multiply your Table 2 score by 1.5. It takes more energy to heat a home in the mountains than in Denver. Our score above of 388 would be $388 \times 1.5 = 582$ if the home is in the mountains.

ENERGY SPENDING POINTS WARMING UP

(Multiply by 1.5 if you live above 5,000 feet.)

TABLE 2

Warming Up			Number of Rooms in Home									
			4	5	6	7	8	9	10	11	12	
Furnace Type	Insulation Grade	APT.			Floor Area in Square Feet							
		100	200	300	1,000	1,500	2,000	2,500	3,000	3,500	4,000	
Gas, Propane or Oil	None	338	472	606	677	808	1173	1408	1627			
	Poor	213	286	348	423	488	577	681	723			
	Good	179	248	301	370	433	508	588	638			
	Excellent	157	227	244	299	343	413	472	528			
Electric*	---	363	436	522	688	747	898	998	1098			
With full storm windows/doors.	Gas	36	46	64	86	73	91	100	100			
	Elec.	67	90	131	127	196	160	183	212			
SUBTRACT												
Good caulking, weatherstripping.	Gas	27	36	46	60	64	73	91	100			
	Elec.	48	72	92	100	136	148	163	186			
SUBTRACT												
Relative House Size		SMALL			MEDIUM			LARGE				

* We're assuming an all-electric home meets high insulation standards. If yours has storm windows and doors and good caulking and weatherstripping, don't forget to subtract the appropriate points.

For Mobile Homes Only

Many older mobile homes use a great deal of energy for space heating. Some newer models are far more energy efficient. If you live in a mobile home, use Table 3 to determine your ENERGY SPENDING POINTS based on size and insulation.

TABLE 3

MOBILE HOMES				APPROXIMATE DIMENSIONS			
				16x56	12x74	16x74	24x74
				FLOOR AREA IN SQUARE FEET			
TYP.	WALL	CEILING	FLOOR	599	699	1199	1,799
New, "Energy Efficient"	R-19	R-37	R-22	237	308	380	418
New, Exc. Insulation	R-11	R-30	R-13	248	318	388	432
Good Insulation	R-8	R-11	R-8	258	328	373	480
Old, Poor Insulation	R-5	R-8	R-14	278	369	419	486
If unit is altered, SUBTRACT				30	39	59	80
RELATIVE MOBILE HOME SIZE				SMALL		MEDIUM	

ENERGY SPENDING POINTS
FOR MOBILE HOMES ONLY

Are You In Hot Water?

Many of us take hot water for granted. Turn on the faucet, wait a minute and there it is. But it's no cheap matter. Your hot water heater is the second largest energy user in the home. The amount of energy you consume for heating water depends on the size of your family and your water use habits. A leaky hot water faucet, for example, can waste up to 700 gallons a year. Use Table 4 to score your ENERGY SPENDING POINTS for hot water.

TABLE 4

HOT WATER	FAMILY SIZE		
	1-2	3-4	5-up
Basic hot water needs (gas)	48	65	53
Basic hot water needs (electric)	90	108	128
Each leaky hot water faucet	3	3	3

ENERGY SPENDING POINTS
ARE YOU IN HOT WATER?

Cooling It

Most Colorado homes are not air conditioned. In fact, air conditioning usually is not needed because of low humidity and cool nights in most areas of the state. Evaporative coolers, sometimes called "swamp" coolers, use far less energy to operate than refrigeration-type air conditioners. They cost less to operate too. Use Table 5 to score your ENERGY SPENDING POINTS for cooling it in the summer.

TABLE 5

SUMMER COOLING	HOUSE SIZE		
	SMALL	MEDIUM	LARGE
All natural ventilation, no fans or air conditioners	0	0	0
For each electric fan (circulating)	1	1	1
For each room air conditioner	20	20	20
For central air conditioning	17	29	43
For each evaporative cooler	5	7	11
For each electric attic fan	5	7	10
For each electric window fan	4	4	4

ENERGY SPENDING POINTS
COOLING IT

Keeping The Home Fires Burning?

Your home fireplace provides little additional heat. In fact, most fireplaces are energy losers. Heat from the fire and warm air from your home is lost up the chimney. That means your furnace must work harder to heat your home while you burn a fire in your fireplace. That's wasting energy and money.

If you use your fireplace at least once a week during the winter, add 84 ENERGY SPENDING POINTS to your score.

If your fireplace doesn't have a damper, add 24 ENERGY SPENDING POINTS.

ENERGY SPENDING POINTS
KEEPING THE HOME FIRES
BURNING?

Energynote

The Energy Blanket: INSULATION

Insulation works the same way as an extra quilt on your bed. It surrounds your home with material that creates "dead" air spaces, which slows down the loss of heat. Insulation is measured in terms of "R-value" per inch, which indicates the material's resistance to the flow of heat. The higher the R-value, the better the insulating capacity.

The most common insulation types are cellulose, fiberglass and mineral wool. Cellulose is made from finely ground paper or cardboard treated with chemicals to reduce flammability. Fiberglass and mineral wool are made from strands of molten glass and rock.

All three are available in "loose fill" form, which can be poured from large bags or blown with machines into attics and other areas. Fiberglass and mineral wool also come in "batts" or "blankets" of standard thicknesses and widths designed to fit snugly between wall studs, floor joists and ceiling joists.

Other insulation types include loose fill vermiculite, (a cork-like material made from expanded mica), fiberglass and plastic foam boards and expandable plastic foams.

Determine what type of insulation you have in your attic or ceiling and measure the depth. Check the walls by removing an electric switch plate to see what's in there. Don't forget to remove the fuse or turn off the circuit breaker first. Use this chart on insulation R-values to determine the R-values of the materials in your home.

INSULATION R-VALUES

	R-11	R-13	R-19	R-22	R-30	R-38
BATTS/BLANKETS						
Fiberglass	3 1/2"	4"	6"	7"	9 1/2"	12 1/2"
Mineral Wool	3 1/2"	4"	6"	7"	9 1/2"	12 1/2"
LOOSE-FILL						
Fiberglass	5"	5 1/2"	8 1/2"	9 1/2"	13"	17 1/2"
Mineral Wool	4"	4 1/2"	6 1/2"	7 1/2"	10"	13"
Cellulose	3"	3 1/2"	5 1/2"	6"	8 1/2"	10 1/2"

(R-)

Your ceiling insulation

(R-)

Your wall insulation

Here's how to figure your insulation Grade for Table 2:

NONE - No insulation at all.

POOR - No wall insulation and up to R-11 in ceilings.

GOOD - No wall insulation and up to R-30 in ceilings.
Or, R-11 in both walls and ceilings.

EXCELLENT - R-11 in walls, R-19 in ceilings or higher.

A rule of thumb:

Most homes built in Colorado after October 1, 1977, have to comply with the Colorado Energy Conservation Code which requires minimum insulation levels of R-19 in the ceiling and R-11 in the walls. Also required are double-pane windows and weatherstripping around the doors. On Table 2, such a home would have "Excellent" insulation and would receive credits for storm windows, storm doors, caulking and weatherstripping.

Many homes built in the last five years probably have R-11 in the walls and R-11 or R-19 in the ceilings ("Good" to "Excellent").

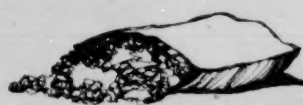
Older homes, especially made of brick and masonry, usually have no wall insulation and little ceiling insulation ("Poor").



Boards



Batts or Blankets



Loose Fill

Your Home Energy Spending

Warming Up

For Mobile Homes Only

Are You In Hot Water?

Keeping The Home

Pics Burning?

Cooling It

Your Total Score

What Your Score Means

Less than 40%

the most for an energy-wise lifestyle. The section on Saving Home Energy can help you

40 to 60%

is about average in the point range. Take a close look at the energy saving tips in the

More than 60%

are doing pretty good. So, to keep things there, do the positive number 1 way that

Saving Home Energy

There are many ways to save energy. You can increase the energy efficiency of your home, the heating and cooling systems and the domestic hot water system, or you can change your lifestyle to be more energy-conscious in your daily life. This doesn't mean sacrifice. It can be as simple as not leaving lights on in empty rooms or turning down the thermostat a few degrees.

This section of The Energy Scorecard takes a look at these energy saving steps you can take in your home. Give yourself credit for those you've already taken and for those you will take in the next three months by recording ENERGY SAVINGS POINTS. Add up the points at the end of the section to see how you could improve your Energy Score.

The Complete Warm Home

In the winter your home loses heat through walls, foundations, windows, doors and cracks. To earn ENERGY SAVINGS POINTS and reduce your monthly energy bill, you need to slow down the heat loss.

Here are five ways to do that in the order they should be performed in your home. These steps are ranked in order based on the greatest energy savings for the lowest cost:

- Lower the indoor temperature
- Stop air leaks
- Maintain your heating system
- Add insulation
- Reduce heat loss through windows with storm windows



What's Your Home's Temperature?

In most cases, home temperatures don't need to be higher than 68 degrees. Thermostat adjustments cost you nothing but can save a lot of energy and money. Use Table 6 to figure out your ENERGY SAVINGS POINTS for lowering your thermostat. Give yourself credit for what you've already done and what you will do in the next three months.

Remember to multiply your score from the table for each degree you set your furnace thermostat back permanently from 72 degrees.

Table 6 also includes scores for turning down the heat each night when you go to bed or when you go to work. This only applies to the number of degrees the thermostat is set back from your average setting.

Example: By setting your thermostat at 68 degrees permanently, you'd get 36 points in a medium sized home heated with natural gas (4 x 9 points). You'd get another nine points if you turn the heat down to 65 degrees at night (68 - 65 = 3; 3 x 3 = 9 points).

TABLE 6

TEMPERATURE	HOUSE SIZE		
	SMALL	MEDIUM	LARGE
For each degree setback permanently	Gas 6 Electric 9	6 18	18 21
For each degree setback nightly	Gas 3 Electric 3	3 6	6 7
For each degree setback during workday	Gas 2 Electric 3	2 5	5 7

ENERGY SAVINGS POINTS
YOUR HOME'S TEMPERATURE

The Great (Air) Escape

For a very small investment of money and labor you can plug most cracks that let cold air into your home. These air leaks are often the greatest cause of heat loss in your home.

Weatherstripping can control air leaks around doors or windows. Caulking around door and window frames, above the foundation wall, around chimneys, in corners and where pipes or wires enter the house can also control these leaks.

Opening doors and windows frequently is another major source of cold air. Try to use a door protected by a closed area. Entering your house through the garage, an enclosed porch or a vestibule can save a lot of heat at no cost.

Table 7 can help you assess your ENERGYSAVINGSPOINTS for stopping THE GREAT (AIR) ESCAPE.

Note: If you already have caulked and weatherstripped, you have been given credit for these steps on Table 2 (Warming Up) in the Spending Home Energy section. Record these points in this section only if you haven't taken these steps but plan to soon.

TABLE 7

THE GREAT (AIR) ESCAPE		HOUSE SIZE		
		Small	Medium	Large
Caulk/Weatherstrip	Gas	25	35	45
	Electricity	25	35	45
Exclusive use of protected door or vestibule	Gas	25	35	45
	Electricity	25	35	45

SEAL CAULKING
between WEATHERSTRIPPING



ENERGY SAVINGS POINTS
THE GREAT (AIR) ESCAPE

Checkup For Your Furnace

Without proper maintenance your furnace works harder and uses more energy. Ask a service representative, perhaps from your local utility, to show you how to change air filters if your furnace has them. Try to change or vacuum filters monthly during the heating season.

Ask the service representative to help check your entire system for things that might need work. Seal leaks in the ductwork with tape and insulated ducts exposed to cold in crawl spaces, attics or garages. If you have hot water or steam heat, make sure the pipes are well insulated.

If you are considering replacing your furnace, consider it carefully since the investment could be a major one. Look into high efficiency models.

Automatic flame dampers or electronic ignition devices can be added to your present furnace. Make sure you buy products approved by your local building department or the American Gas Association.

Table 8 will help you figure ENERGYSAVINGSPOINTS for improving the efficiency of your heating system.

TABLE 8

FURNACE CHECKUP		HOUSE SIZE		
		Small	Medium	Large
Insulate hot air ducts or hot water/steam pipes	Gas	45	55	115
	Electricity	51	143	157
Install high efficiency furnace	Gas	34	43	59
	Electricity	40	74	95
Install automatic flame damper control	Gas	17	36	41
Install electronic pilot light	Gas	5	10	13
Regular furnace tune-up	Gas	7	13	18
	Gas	7	13	18
Clean filters, registers, vents and radiators	Gas	3	4	6
Turn off pilot light in summer	Gas	3	4	6

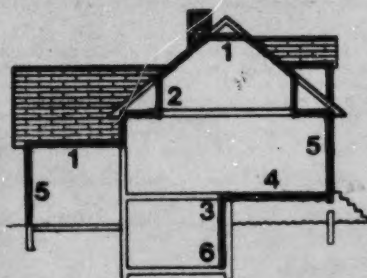
ENERGY SAVINGS POINTS
CHECKUP FOR YOUR FURNACE

Insulation, Your Home's Winter Coat

Of the five key ways to stop heat loss in your home, insulation is one of the most complicated and can be the most expensive. This is the area in which you are most likely to hire an outside contractor. You can install your own insulation at substantial savings, but unless you choose proven materials and install it properly you could be faced with a serious health or safety problem.

The Spending Home Energy section of The Energy Scorecard contains the basic information on insulation types and R-values.

Insulate the easiest and least expensive areas of your home first. Here's the order in most cases, for existing homes: 1. ceilings with cold space above, 2. rafters and "knee" walls in finished attics, 3. top of foundation wall, 4. floors over unheated spaces, 5. uninsulated exterior walls or walls between heated and unheated areas, 6. walls of finished or heated basement. (See diagram)



If you plan to reinsulate, take a look at Table 2 (or Table 3 for a mobile home) in the Spending Home Energy section and refigure your spending points based on the new level of insulation. The difference between your previous score and the new one is your ENERGYSAVINGSPOINT score for improved insulation.

Note: If you already have improved your insulation grade, you've been given credit for this step in your Table 2 score from the Spending Home Energy section. Thank you for saving energy.

Example: Your 1500 square foot gas-heated home with "POOR" insulation (none in walls and R-11 in ceiling) gives you 482 ENERGYSPENDINGPOINTS from Table 2. Adding enough ceiling insulation to increase the grade to "GOOD" (R-19) results in a score of 423. The difference between these scores — 59 points — is your ENERGYSAVINGSPOINT score for improving your insulation. Now figure yours.

ORIGINAL TABLE 2 SCORE

(-) NEW TABLE 2 SCORE

DIFFERENCE

= ENERGY SAVINGS POINTS
INSULATION

Windows On The World

Storm windows reduce heat loss because they form a dead space of air between the storm and main window. This prevents the wind from hitting the inside window and pulling heat from the home.

Windows are uninsulated openings in your house. Adding storm windows can cut the heat loss through a single pane in half. Heavy plastic can be used as low-cost storm windows. Remember that storm windows on the north side of your home are more cost-effective than those on the south side.

Closing drapes at night helps keep heat in. Opening them during the day allows heat from the sun to warm your house. Do-it-yourselfers can make insulated shutters for windows using an inch or two of insulation sandwiched between sheets of thin paneling.

Tight-fitting and well-constructed storm doors form a dead space of air between two doors, and like some storm windows, they can be expensive.

TABLE 9

WINDOWS ON THE WORLD		HOUSE SIZE		
		Small	Medium	Large
Add storm windows	Gas	31	47	79
	Elec.	81	110	148
Add storm doors	Gas	17	21	26
	Elec.	38	48	49
Close drapes at night		13	21	29
Insulating shutters on windows Closed at night		26	42	58

Note: If you already have storm windows and doors, you've been given credit for them in Table 2 of the Spending Home Energy section. Take credit for this step here only if you plan to add storms in the near future.

Use Table 9 to determine your ENERGY SAVINGS POINTS.

ENERGY SAVINGS POINTS
WINDOWS ON THE WORLD

☐

Staying Out Of Hot Water

Two ways to cut energy used for hot water are making the system more efficient and changing your hot water use habits.

Increasing efficiency isn't hard. Begin by fixing any leaky hot water faucets. Install flow restrictors in shower heads. Reinsulate your hot water tank with any of several handy kits now available and cut energy consumption by 10 percent. Flush energy-robbing residue that builds up in the bottom of your hot water tank at least once a year. Several buckets of water removed from the tank's drain faucet should do the job. Lower the thermostat as far as your family will accept, from 140 to 110 degrees or from "high" to "medium" or "low". And don't forget to turn off the hot water heater when you leave home for more than three days.

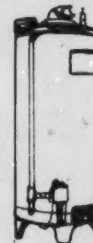
If you buy a new unit, get an energy efficient one. Look for models with electronic ignition devices and automatic flue dampers.

Slight, but important, changes in your hot water use habits can save you energy and money. Take shorter showers or replace bathtubs with showers. Don't let hot water run unused. Wait until dishwashers or clothes washers are full before turning them on, unless they have settings for partial loads.

Table 10 will help you score your ENERGY SAVINGS POINTS in this area based on what you've already done or will do in the next three months.

STAYING OUT OF HOT WATER		FAMILY SIZE		
		1-2	3-4	5-up
Insulate hot water tank	Gas	5	7	8
	Electricity	9	11	13
Flow restrictors on showers	Gas	7	10	13
	Electricity	13	18	19
Flow restrictors on faucets	Gas	5	7	8
	Electricity	9	11	13
Repair leaky faucet (points per faucet)	Gas	3	3	3
	Electricity	5	5	5
Lower thermostat setting 140° to 110°	Gas	12	16	21
	Electricity	23	27	32
Flush tank annually	Gas	2	3	4
	Electricity	5	5	6
Turn off while away	Gas	2	3	4
	Electricity	5	5	6
Conserve hot water (short showers, full loads, etc)	Gas	5	7	8
	Electricity	9	11	13
Replace with high efficiency model	Gas	12	16	21
	Electricity	23	27	32

TABLE 10



ENERGY SAVINGS POINTS
STAYING OUT OF HOT WATER

☐

Efficient Home Fires

Improve the efficiency of your home fireplace by adding glass doors to prevent the escape of warm air after the fire has gone out. Or add an air circulator that fits inside the fireplace and blows warm air into the room. If there's no damper on your fireplace, consider installing one.

If you are thinking about adding a fireplace to your home or are in the process of building a home, consider installing an air-tight wood stove or a circulating fireplace. See the special section on Energy Alternatives for more details.

Use Table 11 to assess ENERGY SAVINGS POINTS for steps you have taken or will take in the next three months to improve the efficiency of your fireplace.

ENERGY SAVINGS POINTS
EFFICIENT HOMES FIRES

☐

Table 11

Efficient Home Fires	Savings Points
Install Damper	24
Install Glass Screen	28
Install Air Circulator	6

Cool It - Efficiently

Weatherizing your home for cold winter weather also makes it easier to keep cool in the summer. The best way to save energy in this area is to stop using air conditioning, which generally isn't needed in much of Colorado.

In fact, before you buy an air conditioner consider some other steps first. Here's a quick list of cooling methods in order of cost-effectiveness:

- **NATURAL VENTILATION** — Open lower windows on the shaded and north sides of the home and those on the upper sunny sides. The flow of the warm air out the top will bring cool air in from the bottom.
- **LANDSCAPING** — Fences, shade trees, vines and shrubbery can help shade part of the house in the summer and keep it cool.
- **ROOM FANS**
- **ATTIC FANS**
- **EVAPORATIVE(SWAMP)COOLERS** — They use water evaporation to cool part of the house at a much lower energy cost than air conditioners.
- **ROOM AIR CONDITIONER**
- **CENTRAL AIR CONDITIONER**

If you do use air conditioning, Table 12 shows you how to assess **ENERGY SAVINGS POINTS** for various conservation measures.

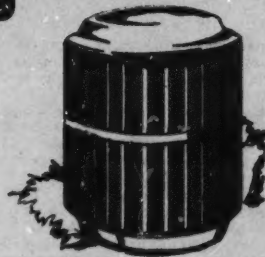


TABLE 12

CENTRAL AIR CONDITIONING	ENERGY SAVINGS POINTS
Install awnings or shade plants on east, west and south side of home to keep house cooler	14
Increase temperature inside from 78° to 75°	9
Increase temperature inside from 78° to 80°	18
ROOM AIR CONDITIONER	
Use in one room only and keep door closed	5
Set temperature at 80°	5

ENERGY SAVINGS POINTS
COOL IT — EFFICIENTLY

☐

Your Home Energy Savings

Your Home's Temperature
The Great (Air) Escape
Checkup For Your Furnace
Insulation
Windows On The World
Staying Out Of Hot Water
Efficient Home Fires
Cool It - Efficiently

Your Total Score

☐

How are you doing?

Figure your Net Energy Score for the Home. That tells how much you could be spending if you begin to save.

**HOME
ENERGY SCORE**

Spending

Saving

Net Energy Score

If your score is below 435, you're doing a lot to save or could do a lot to save. You're average with a score between 435 and 565 points. Above 565 means you are a big energy user.

Spending Appliance Energy

More than 10 per cent of the energy you use goes into running appliances. Before you buy a new appliance, ask yourself how much human energy it will save and how much electrical energy it will consume. Make sure the appliance is properly sized to your needs and is energy efficient.

Read appliance instructions and don't put off repairs. Improperly operated appliances and worn parts waste energy and money.

Note: If you use clothes washers and dryers in a laundromat or in your apartmenthouse, you still must record points for them.



Refrigerators • Freezers

Size and defrosting method are the key factors affecting the amount of energy consumed by refrigerator/freezer units and separate freezers.

Make sure door seals are airtight. Don't leave doors open and keep the coils clean. If you buy a new unit, consider one with manual defrosting or a "power saver" switch that cuts off some energy-robbing heating coils in frost-free units.

Use Tables 13 and 14 to determine your ENERGY SPENDING POINTS based on the size and type of your refrigerator/freezer or freezer. Add up points for each unit you own.

TABLE 13

REFRIGERATOR/FREEZER		
SIZE (Cubic Feet)	POINTS	
	MANUAL DEFROST	AUTO DEFROST
8 (Compact)	9	10
12 (Apartment)	18	27
14 (Average Home)	27	36
17 (Large)	36	45
18 (Giant)	45	54

TABLE 14

FREEZER		
SIZE (Cubic Feet)	POINTS	
	MANUAL DEFROST	AUTO DEFROST
7	9	27
12	18	36
16	27	45
17	36	54
19	45	63
22	54	72
31	81	99

ENERGY SPENDING POINTS
REFRIGERATORS/FREEZERS

The Other Gadgets

Use Table 13 to check off any home appliances or devices powered by electricity or gasoline, whether you use them much or not. The ENERGY SPENDING POINT value for each item checked is in the left hand column of the table. If you have more than one of the same gadget, record points for EACH one. Total up each section of the table in the right hand column and add up the scores at the bottom.

TABLE 16

The Other Gadgets

POINTS PER CHECK

		TOTAL
24	— Clothes Dryer (electric) (includes Laundromats)	
17	— Clothes Dryer (gas) (includes Laundromats)	
13	— Color TV (tube type)	
9	— Sump Pump — Lawn Tractor — Snowmobile — Engine Heater — Water Pump — Motor Boat — Dishwasher — Color TV (solid state)	
5	— Air Cleaner — All Terrain Vehicle — Handblower — Waterbed Heater — Portable Heater — S & W TV (tube type)	
3	— Vaporizer — Power Mower (gas or elec.) — Saws — Skunk — Radio — S & W TV (solid state) — Iron — Clothes Washing Machine	
1	— Snow Blower — Vacuum Cleaner — Shredder — Rototiller — Chainsaw — Chainsaw — Lathe — Joiner — Grinder — Arc Welder — Table Saw — Trash Compactor — Hair Dryer — Garbage Disposal — Sander — Garage Door Opener — Mill — Jigsaw	
1/4	— Shower — Knife — Heating Pad — Projector — Games — Water Pick — TV Game — Vibrator — Toothbrush — Typewriter — Calculator — Yogurt Maker — Lawn Trimmer — Drill Press — Hand Drill — Knife Sharpener — Hand Saw — Can Opener — Soldering Iron — Camp Stove — Camp Lantern — Camp Heater — Hedge Clipper — Other	

ENERGY SPENDING POINTS THE OTHER GADGETS

What's Cookin'?



ENERGY SPENDING POINTS for cooking take into account your stove and all counter-top cooking appliances like electric frying pans, broilers or coffee makers. Record 23 points for a family of two to four persons. If you live alone, record 17 points. If there are five or more in your family, record 29 points.

ENERGY SPENDING POINTS WHAT'S COOKIN'?

Lighting Up Your Life

The amount of energy used for lighting depends largely on the number of rooms in your home. Count them, but exclude hallways, bathrooms, closets, unfinished basements and attic.

If you leave a porch or yard light on at night add 5 points. Add 26 points if you have a gas pool light.

Use Table 16 to determine ENERGY SPENDING POINTS.

TABLE 16

Lighting	Average					
Rooms	1-2	3-4	5-6	7-8	9-10	10-12
Points	5	10	15	20	26	31

ENERGY SPENDING POINTS LIGHTING UP YOUR LIFE

Your Appliance Energy Spending

Refrigerators • Freezers

The Other Gadgets

What's Cookin'?

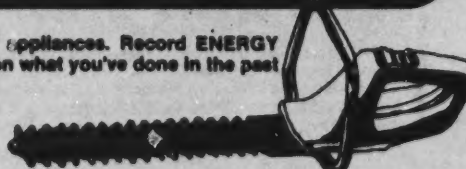
Lighting Up Your Life

Your Total Score

What Your Score Means

Saving Appliance Energy

Now look at ways to cut the energy spent on appliances. Record **ENERGY SAVINGS POINTS** in the squares provided based on what you've done in the past year or will do in the next three months.



Refrigerator

- Decide what you want, then open and close door quickly 5
- Defrost regularly 5
- Switching to new "energy conserving" models with improved motor, insulation and condenser 10
- Switching to smaller unit. Use the Refrigerator / Freezer chart to determine the difference in ENERGY SPENDING POINTS and record that here. For example, switching from a 17 cubic foot manual defrost (30 points) to a 12 cubic foot model (10 points) would result in 10 ENERGY SAVINGS POINTS.

☐

Television

- Turn off when not watching — Black & White 2
- Color 5
- Turn off "instant on" feature — Black & White 2
- Color 5
- Switch from tube to solid state model — Black & White 2
- Color 4

☐

Clothes Washer

☐

- Use cold water wash cycles only 17

Clothes Dryer

- Hang clothes out in warm weather 10
- Hang clothes out all year (they'll dry in the sun even if temperature is below zero) 20
- Use proper fabric setting 2

☐

Freezer

- Decide what you want, then open and close quickly 5
- Keep freezer more than half full 5
- Defrost regularly 5
- Switch to new "energy conserving" model 0
- Switch to smaller model (see instructions in Refrigerator savings section) —

☐

Cooking

- Switch to "energy conserving" stove with extra oven insulation and electronic pilot light (in gas models) 0
- Don't use "self-cleaning" feature 2
- Don't open oven door while baking 2
- Bake two or more dishes at a time 2
- Use small electronic pans or ovens for small dishes instead of the range or large oven 2

☐

Lighting

- Turn off your gas pilot light 20
- Replace half your incandescent bulbs with fluorescent fixtures 7
- Turn off your porch or yard light at night 5
- Clean bulbs and fixtures regularly 4

☐

Dishwasher

- Don't use the "dry" cycle 5
- Don't use at all (hand wash) 0

☐

The Little Items

The items included here have minimal individual effects on your energy spending. But added up, they can make a dent in your monthly utility bill. RECORD ONE ENERGY SAVINGS POINT FOR EACH ITEM CHECKED.

- Locate refrigerator away from heat source
- Keep refrigerator coils clean
- Replace refrigerator door seal if needed
- Keep clothes dryer lint filter clean
- Run full (but not overfull) dryer loads
- Vent your electric dryer inside, but make sure it doesn't get clogged with lint
- Wash gas stove with burner also on stove
- Use pans with flat bottoms, straight sides and tight lids
- Avoid preheating oven
- Keep range-top burners and reflectors clean
- Thaw frozen food in refrigerator before cooking
- Use correct dishwasher cycle and water temperature
- Clean dishwasher screens regularly
- Pull loads only in dishwasher
- Turn all lights off when not in use
- Install dimmer switches in living room and dining room
- Use bright colors for walls, ceilings and decorating (they reflect more light)
- Use large bulbs (100 watts) instead of several small ones in areas where bright light is needed
- Install small bulbs (40 watts) in closets and other areas where bright light isn't vital
- Clean mineral deposits off humidifier
- Compost food scraps instead of using the garbage disposal unit
- Keep blades of all fans clean
- Iron bottles of clothes rather than one or two items at a time
- Empty vacuum cleaner bags before they're overloaded
- Cut the number of wash loads per week
- Use proper fabric setting on clothes washer
- Use proper water level setting on clothes washer
- Keep engines of lawn, garden and recreational equipment or vehicles tuned

Your Appliance Energy Savings

Refrigerator ☐
Freezer ☐
Clothes Dryer ☐
Television ☐
Dishwasher ☐

Clothes Washer ☐
Cooking ☐
Lighting ☐
The Little Items ☐

Your Total Score ☐

Energynote

Energy Note Manufacturing

Energy Note Manufacturing is a leading manufacturer of energy saving products. Our products are designed to help you save money on your energy bills. We have a wide variety of products to choose from, including energy saving light bulbs, energy saving window film, energy saving door seals, and more. We are committed to providing you with the highest quality products at the lowest prices.

APPLIANCE ENERGY SCORE

How are you doing?

Figure your Net Energy Score for Appliances. Now you know where you stand after taking energy conservation into account.

If your Net Energy Score is below 100, you're an energy conserver. You're still with the average if you've got 100 to 120 points. And consider more ways to save energy if your score exceeds 120 points.

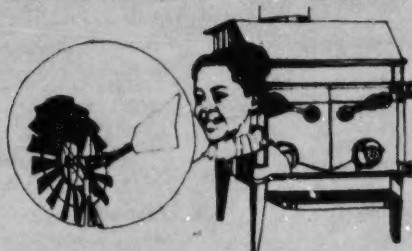
Spending

Saving

Net energy score



Energy Alternatives



As the cost of energy continues to rise, more people are turning to other ways of home heating and cooling and providing electricity. These include the use of solar energy systems, wood stoves, circulating fireplaces and wind generators, to mention a few.

If you are using one of these alternate energy systems or plan to in the near future, give yourself some **ENERGY SAVINGS POINTS** under this special section because your decision to use one of these systems eases the growing need for the disappearing energy resources we've all grown accustomed to.

Solar Energy

Basically, all the energy resources widely used today — gas, oil, coal, hydro-electric power and nuclear — come from the sun originally. Now, more and more systems are being developed that use energy from the sun's rays directly to heat and cool buildings.

This section will deal only with using solar energy for heating. There are three basic types of solar energy systems: active, passive and combinations of the two.

ACTIVE SYSTEMS — These use mechanical hardware to absorb solar energy and convert it to heat for the home. The systems generally consist of a roof-mounted collector covered with glass or plastic, a circulation system that moves heated air or water through a network of ducts or pipes, a heat storage unit to store heat for use at night or on cloudy days, and a system to get heat into the living space. Active systems can be used on new or existing homes and can cost \$5,000 to \$25,000.

Despite the high cost of some solar systems, many people in Colorado have built effective collectors for only a few hundred dollars. They provide no overnight storage, but they do work well for providing some heat.

To determine your **ENERGY SAVINGS POINTS** score for an active solar system, use your Table 2 home heating score as a starting point. If your solar energy system provides 50 per cent of your heating needs, then take 50 per cent of your Table 2 score and check those up as **ENERGY SAVINGS POINTS**. Example: Say your Table 2 score was 300 points and your solar energy system provides 50 per cent of your home heating needs. You'd earn 150 **ENERGY SAVINGS POINTS**.

In Colorado, solar energy systems can meet 75 per cent or more of your energy needs for home heating.

PASSIVE SYSTEMS — These use no complex mechanical controls or hardware and tend to provide heat at a lower cost than active solar energy systems. Often, the passive characteristics are a part of the building itself. Your home becomes the solar collector and heat storage unit. Most passive systems depend on several factors: a southern exposure to capture the most sunlight possible, heat storage in the building, shading and ways to retain the heat at night (such as insulated drapes or shutters on windows). It's difficult to add passive features to an existing home unless you plan some major remodeling. But for new homes, many energy-saving features can be added at little or no additional cost.

There is, however, one thing you can do to your home now. That's to add a greenhouse on the south side. It will allow you to grow food year-round and provide energy for home heating.

To determine **ENERGY SAVINGS POINTS** for a passive system use the method described under Active Systems: estimate how much heat your system provides and then multiply that by your Table 2 score. For an attached greenhouse, give yourself credit for 15 per cent of your score from Table 2.

COMBINED SYSTEMS — These systems are as the name implies, combinations of both active and passive design features. Figure your **ENERGY SAVINGS POINTS** as previously described.

SOLAR HOT WATER HEATERS — These systems, ranging in cost from \$500 to \$1,500 including installation, can provide up to 75 per cent of your family's hot water. Many are available on today's market. Use Table 17 in assessing **ENERGY SAVINGS POINTS** if you have one of these systems. We're assuming your system supplies (or will supply) 75 per cent of your hot water and has either a gas or electric backup hot water heater for cold spells and cloudy weather.

TABLE 17

Solar Hot Water Heater			
Back-up System	FAMILY SIZE		
	1-2	3-4	5-up
GAS	54	48	62
ELECTRIC	67	61	84

Wind Power

Wind energy systems are capable of performing a number of tasks around the home including pumping water, space and water heating and generating electricity. There are a number of companies actively manufacturing, selling, and installing wind energy systems. A complete system consists basically of a wind generator, usually mounted on a large tower, hooked up by a bank of storage batteries to store electricity during low wind periods.

Most wind-electric systems available cost \$5,000 to \$15,000 and produce between 100-500 kilowatt hours per month, roughly 20-100 per cent of the average household consumption for homes that are not electrically heated.

You can record **ENERGY SAVINGS POINTS** if you have a wind generating system at your household, or plan to install one in the near future. Your point score would be based on 30 points per 100 kilowatt hours of capacity which you can attribute to your wind generation system. For example, if you had a system that provided 300 kilowatt hours per month, you could record 90 **ENERGY SAVINGS POINTS** on your energy score.

Wood Heating

Using wood as an alternative fuel can save money and energy when burned in an efficient air-tight wood stove. There are many attractive and efficient units available. Some open up for a fireplace effect when desired. Properly sized and located, a wood stove can heat a large portion of the home's heating needs.

Consider a wood stove or stove/fireplace combination if you are thinking of adding a fireplace to your home or are in the process of building a home. An air-tight unit is up to eight times more efficient than a fireplace. Also, you might consider a circulating fireplace system that can heat several rooms at once.

The large scale use of wood for home heating must be balanced against the ability of forests to replenish themselves and potential pollution problems. With proper forest management and as long as the earth's environment remains healthy, wood will be available for heating, home and paper products.

If a supply is readily available, wood heat can substantially reduce the cost of home heating. It also can be used to supply hot water. An important aspect of wood heating is to make sure it's done safely. Before you install a wood heating system, learn all you can about doing it safely.

If you install a high quality air-tight wood stove to supply heat, give yourself 21 **ENERGY SAVINGS POINTS** for each day of the week you use it. (Example: five-days-a-week use = 105 points.)

If you install a circulating fireplace, give yourself 30 **ENERGY SAVINGS POINTS** for each day it's used in the week.

Table 18 has been provided to help you total up your **ENERGY SAVINGS POINTS** for any alternative energy sources you are using or plan to use.

TABLE 18

ENERGY ALTERNATIVES	ENERGY SAVINGS POINTS
Solar - Active	
Solar - Passive	
Solar - Combined	
Solar Hot Water Heater	
Wood Stove	
Circulating Fireplace	
Wind Power	

ENERGY SAVINGS POINTS
ENERGY ALTERNATIVES

Summing Up

Write down your scores from each of the main sections in The Energy Scorecard. Total them up, and determine your overall Net Energy Score by subtracting all the ENERGY SAVINGS POINTS from the ENERGY SPENDING POINTS. Then, use The Energy Score Board to see how you compare with others.

Transportation			Net Energy Score
Home			
Appliances			
Energy Alternatives			
 -  =			

Mark these scores on The Energy Score Board to see how you stack up against others in Colorado, the nation, Western Europe and the world.

We'd Like To Help

The Colorado Office of Energy Conservation has established a network of community energy conservation centers around the state to help answer questions about energy conservation and renewable energy resources. Also, the state office has established several other information centers for more specialized interests.

Community Centers:

Besa County Energy Office
c/o Paul Feltz
Southwest Colorado Research Center
P.O. Box 477
Walsby, CO 81086 394-8843

Boulder Center for Energy Conservation
c/o Jim Hoshel, Lynda Krotzsch
3285 Broadway
Boulder, CO 80502 443-8843

Durango Energy Conservation Center
c/o Barbara Blunt
La Plata County Extension Building
P.O. Box 1808
Durango, CO 81301 393-1808

Grand Junction Public Energy Information Office
c/o Karen Hastings, Joyce Jenkins
388 North 9th Street
Grand Junction, CO 81501 243-2623 ext. 364

Larimer County Energy Extension Office
c/o Don Floyd
Larimer County Courthouse
P.O. Box 840
Ft. Collins, CO 80522 221-2100 ext. 261

San Luis Valley Energy Center
c/o Bob and Julie Dunsmore
525 Main
Alamosa, CO 81101 486-3233

Summit County Energy Extension Office
c/o Richard Topolise
CSU Extension Building
P.O. Box 78
Frisco, CO 80443 468-8888

Other Information Sources

General information and research services:

Colorado Office of Energy Conservation
1808 Downing Street
Denver, CO 80218 626-8807

Regional Energy/Environment Information Center
Denver Public Library
1367 Broadway
Denver, CO 80203 637-8894

Businesses:

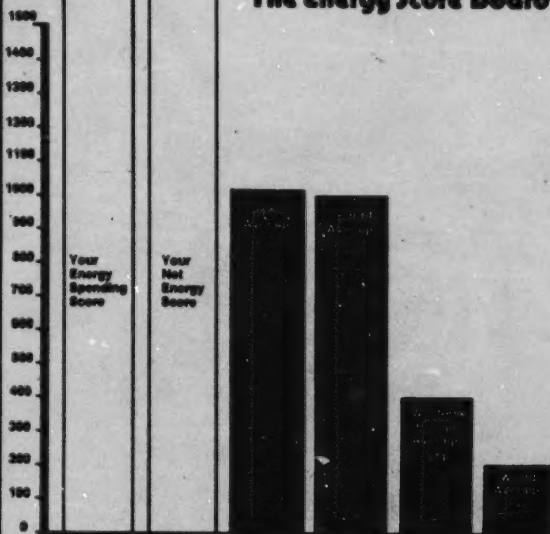
Colorado Energy Conservation/Alternatives Center
The RNL Building
1676 Sherman Street
Denver, CO 80203 661-1888

Colorado State University
Cooperative Extension Service
c/o Lloyd Walker
Fort Collins, CO 80523 461-8253

OR

Your County Extension Agent's Office

The Energy Score Board



Mark your Energy Spending Score and Net Energy Score from "Summing Up" in the first two columns of The Energy Score Board to see how you compare with average household energy use in Colorado, the U.S., Western Europe and the world.

The Buck Stops Here

We'd Like To Hear From You

For information, clip this coupon, fill it out and send it to the nearest community center or to the Office of Energy Conservation. Addresses are in the "We'd Like to Help" section.

INFORMATION

I'd like more information on the following topics:

- ☐ Financing energy conservation improvements ☐ Utility Rates
☐ Insulation, weatherstripping, caulking, storm windows/doors
☐ Transportation ☐ Appliances ☐ Furnace upkeep
☐ Solar Energy ☐ Wood Stoves/Fireplaces ☐ Wind Power
☐ Other _____

Name _____

Address _____

City _____ State _____ Zip _____

Phone (optional) _____

FEEDBACK

We'd appreciate your answering these quick questions for us. It's optional, but helps us evaluate our programs. So we can determine geographical responses, please indicate your zip code _____.

How did you do on The Energy Scorecard?

	Spending	Savings
Transportation		
Home		
Appliances		
Energy Alternatives		

What actions are you taking?

- ☐ Carpool, vanpool, bus to work/school
☐ Turning down thermostat in winter ☐ Using appliances more efficiently
☐ Lowering hot water setting ☐ Caulking and weatherstripping
☐ Servicing heating system ☐ Installing storm windows/doors
☐ Insulating attic ☐ Maintaining auto/truck

What Will You Need To Do?

1. Order a quantity of Energy Scorecards sufficient to meet your students' needs (one per student) from:

Mr. Robert P. Brown
Director, Energy Extension Service
Colorado Office of Energy Conservation
1600 Downing
Denver, CO 80218
839-2507

2. Familiarize yourself with the Energy Scorecard and the Introduction to this guide.
3. Read the suggested activities for your discipline, choosing those which are most appropriate for your students.
4. Prepare related materials as suggested in your chosen activities.
5. If required in your district or if desired, duplicate the "parent commitment" letters for distribution. (See Appendix).
6. Teach!

GENERAL SEQUENCE OF MINI-UNIT

DAY 1

**Teacher's
Plan:****Introduction:**

Distribution: Parent cover letter and Energy Scorecards

Discussion of "How To Use It", p. 2 (10 min.)

Activities: (Choose 30 minutes of introductory activities)

**Student
Assignment:**

Skim Energy Scorecard; Ask parents for commitment in assisting with assignment; Reread p. 2; Complete "Spending Transportation Energy" and "Saving Transportation Energy" sections, pp. 3-5.

DAY II

**Teacher's
Plan:**

Discussion of Assignment: "Spending & Saving Transportation Energy"
(10 min.)

Activities: Choose 30 minutes of support activities related to Transportation

Student

Assignment: Complete "Spending Home Energy" and "Saving Home Energy" sections, pp. 6-11.

DAY III

**Teacher's
Plan:**

Discussion of Assignment: "Spending and Saving Home Energy" (10 min.)

Activities: Choose 30 minutes of support activities related to
Home Heating and Cooling

**Student
Assignment:**

Complete "Spending Appliance Energy" and "Saving Appliance
Energy" sections, pp. 12-14.

DAY IV

**Teacher's
Plan:**

Discussion of Assignment: "Spending and Saving Appliance Energy" (15 min.)

Activities: Choose 30 minutes of support activities related to Appliances

**Student
Assignment:**

Complete "Energy Alternatives" and "Summing Up" sections,
pp. 15-16.

DAY V

Teacher's
Plan:

Discussion of Assignment: "Energy Alternatives" (15 min.)

Discussion of "Summing Up" (15 min.)

Activity: Choose 1 Culminating Activity related to Future Energy

Collect "Feedback" coupons, p. 16.

We would like to hear from you!

We are interested in your comments. Was Accounting For Household Energy Consumption a worthwhile experience for your students and their families?
What can we do to improve it?

Please help us monitor usage of this mini-unit by sending us the "Feedback" coupons collected from your students. No names are necessary unless families wish to receive any additional information specified on the coupon.

Classroom Activities

The learning activities which follow have been designed for use in a one-week mini-unit or module. The core of the module is the Colorado residential energy audit, "The Energy Scorecard", and the associated activities can be used in conjunction with it in home economics, mathematics, science and social studies classes at the junior high level.

Activities associated with each discipline listed above have been placed on color-coded stock for easy reference. They are, by no means, comprehensive; rather, they are intended as suggestions which will facilitate the classroom implementation of "The Energy Scorecard". Teachers are encouraged to modify them or to use activities from other sources whenever necessary to meet the unique needs of their pupils.

The four sections devoted to each of the disciplines have been subdivided into five-day modules, containing step-by-step procedures for implementing each activity. More activities than will be needed have been included for flexibility. Each has been designed so that teachers may detach pages of interest, making transparencies and/or ditto masters of relevant charts, figures, tables and graphs from them. Additionally, since the suggested activities are different for each discipline, teachers in the same school can implement the mini-unit without concern that students are exposed to repetitive exercises. A "Glossary of Energy Basics" has been included for your convenience.

DAY 1 ACTIVITIES

INTRODUCTION

Choose one, two or three activities from the following list, using them to introduce students to U.S. energy problems.

Objective

The student will be able to understand the root causes of the U.S. energy dilemma and the need to conserve energy fuels.

#1

Activity Title: "Nightmare Life Without Fuel"

Background: Science writer Isaac Asimov was asked by Time for his vision of what life might be like in 1997 should the fossil fuel barrel run dry.

Time Required: 25 minutes

Materials: Copy of "The Nightmare Life Without Fuel"

Procedure:

1. Read the article aloud to the class.
2. Ask students if they agree with Asimov's final statement: "And what can we do to prevent all this now? Now? Almost nothing. If we had started 20 years ago, that might have been another matter. If we had only started 50 years ago, it would have been easy."
3. What things should be done now to lessen the chances of Asimov's "nightmare" coming true?

Reference: Adapted from Energy and/or Earth, Jefferson County Schools, pp. 200-203.

PAGE HE-2 "THE NIGHTMARE OF LIFE WITHOUT FUEL"
REMOVED DUE TO COPYRIGHT RESTRICTIONS.

Activity Title: "The Food System's Share of U.S. Energy Consumption"

Background:

Since energy is the capacity to do work, it is an essential part of all processes: biological, physical, and socioeconomic. All living things require energy input.

Our present technological society uses three times the energy required by 19th Century industrial man and ten times that required by the advanced agricultural societies of 13th Century Northern Europe. We now use 26% of our energy for transportation, over 37% for household and commercial purposes and the remainder for industrial production.

The demand for energy has been growing at an exponential rate. So rapid has been the use of energy that it exceeds the population growth rate by a factor of four, resulting in significant per capita consumption increases. Electric power generation has been growing at 7-10% per year. The trend toward more electricity tends to reduce the overall efficiency of the system by substituting a thermal efficiency of 30-40% for direct fuel uses with efficiencies of up to 90%. Air conditioning alone represents over 15% of the total increase in electric power generation in the early 1970's.

The shift toward more non-durable (disposable) goods and high-horse-power automobiles had measurable effects on the rate of energy use. The U.S., with about 6% of the world population, requires about 35% of the global output and produces more than 50% of the consumer goods.

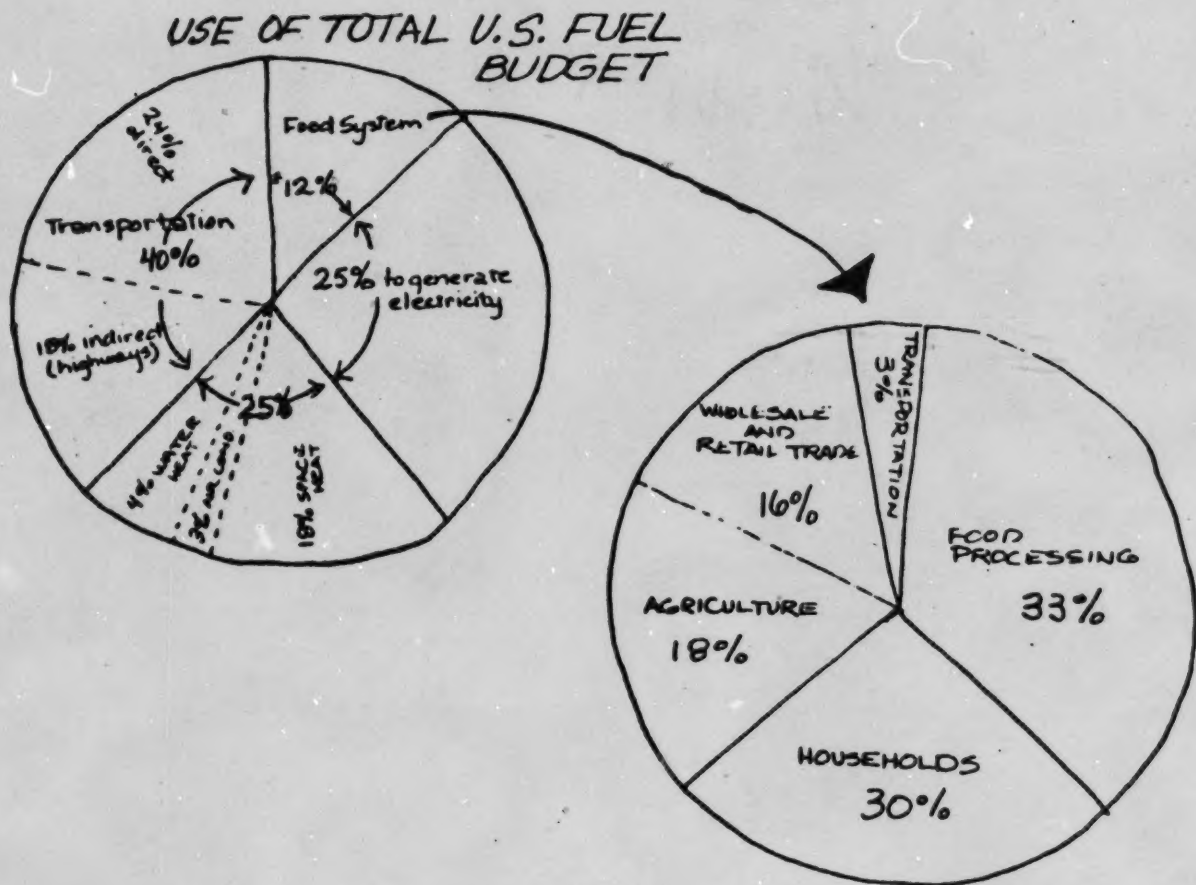
Time Required: 15 minutes

Materials: Chalkboard/overhead projector

Procedure:

1. Copy Fig. 1 onto the chalkboard or overhead transparency.

2. Discuss specific factors which contribute to energy consumption in each sector of the food "pie".



ENERGY USE IN THE U.S. FOOD SYSTEM

Fig. 1

References: "Sources of Energy", Activity Guide, Energy & Man's Environment, 1976, Introduction.

Background:

It has been estimated that the average American uses the following energy resources each day: 13.6 pounds of coal, 3.3 gallons of oil, 297 cubic feet of natural gas, 3.7 kilowatt-hours of hydroelectric power, and .7 kilowatt-hours of nuclear power. In a lifetime, a person in the U.S. consumes 170 tons of coal, 2,000 barrels of oil, and 7.5 million cubic feet of natural gas.

If you had lived in the year 1900, you would have used only 25% of the energy you use today. In the year 2000 you will use almost twice as much as you use today if demand continues at the present rate. Additional energy sources exist, but require research for practical development and implementation, and that requires time and money.

The time has arrived for an energy transition, but this one will be unlike the two the U.S. has previously experienced. After the Civil War, coal replaced wood, windmills, and waterwheels. In the 1950's, oil and natural gas replaced coal. These transitions were not the result of shortages as is the present one. If we act now to conserve our present energy resources and to develop additional energy sources, the transition can be orderly. If delays arise too frequently and voluntary cooperation does not occur, more drastic measures such as rationing, will be enacted to conserve our energy fuel reserves.

Time Required: 15 minutes

Materials: Overhead projector

Procedure:

1. Make an overhead transparency of Fig. 1.
2. Use it to discuss U.S. sources of energy and the ways we use energy.

Reference: Energy Conservation Activity Packet, Iowa Energy Policy Council and Dept. of Public Instruction, 1977. pp. 21,22,32.

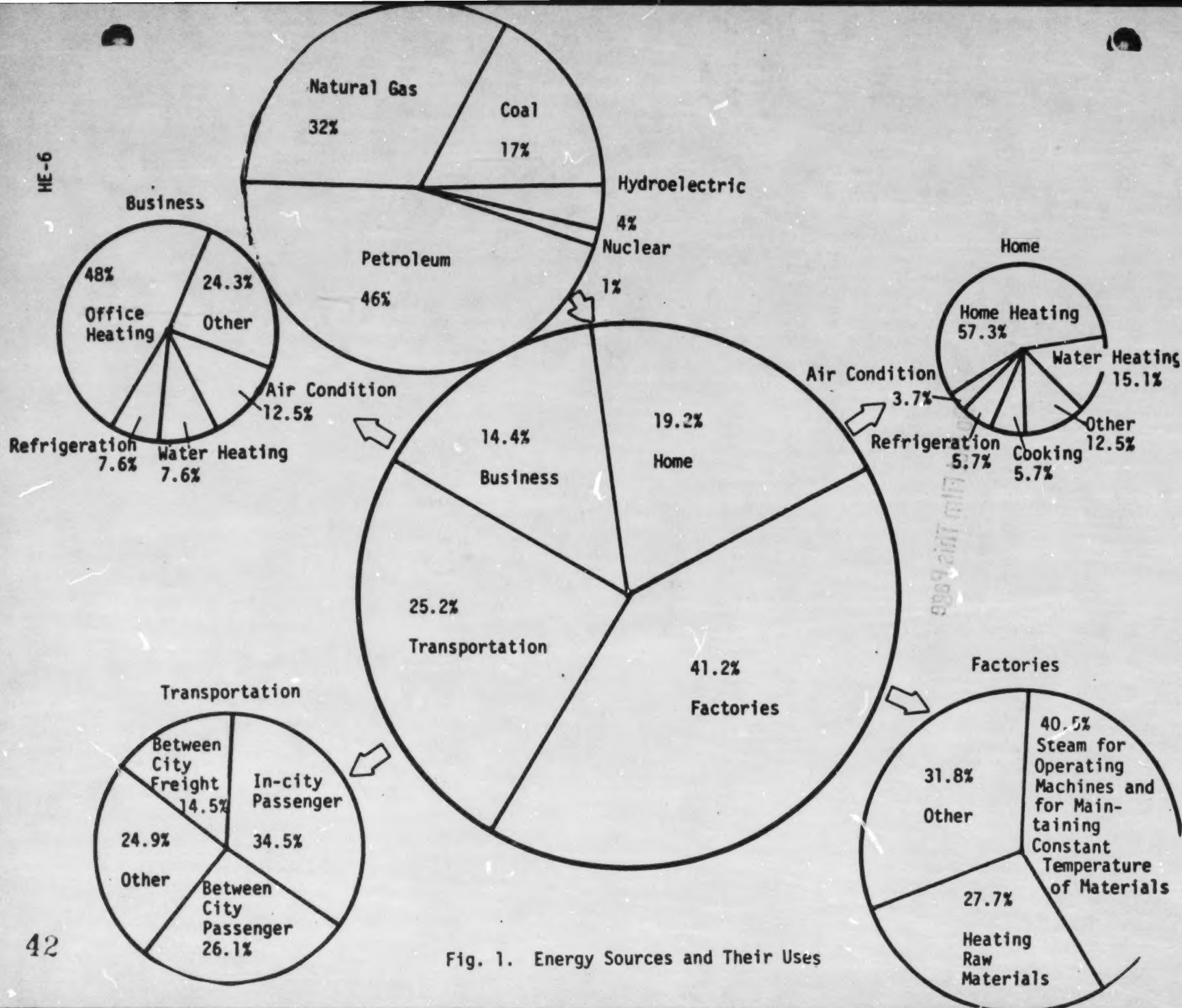


Fig. 1. Energy Sources and Their Uses

#4

Activity Title: "Energy Spaghetti"Background:

Energy flow in the natural world and the human enterprise is governed by two physical laws called the laws of thermodynamics.

The first is: Energy can neither be created nor destroyed. We can never run out of energy. Where then is the problem? The problem is in the second law: "In any conversion of energy from one form to another, some of it becomes unavailable for further use."

To state the second law another way: as energy is used, it degrades from an orderly, high-quality state to a less orderly, lower state. This is true, for example, of a burning bulb, in which energy moves from high-quality radiant energy to low-quality heat, or waste energy. It is true of the high-quality energy that fuels an electricity generating plant and is transformed into electricity. Most of it becomes heat of such low quality that it is dispersed to the natural environment - up the stack or through cooling water. Though abundant, it can't be reconcentrated, and, so far, not much has been done in the United States to harness some of this degraded form of energy to do effective, useful work. It is true, also, of the energy used in an automobile. In some settings, this waste energy actually becomes a pollutant.

The laws of thermodynamics tell us that while energy cannot be lost, merely possessing it is of no value. Energy is valuable only insofar as it is used to generate work, to produce power. What inevitably diminishes is not the world's constant stock of energy, but its ability to do what we value - work.

In this country last year nearly one-half of the energy we produced was

not available for useful work. In essence, it was "wasted". We "wasted", due to the inefficiencies of conversion, more energy than Japan used!

Time Required: 10 minutes

Materials: Overhead projector

Procedure:

1. Make a transparency of Fig. 1.
2. Use it to discuss the sources, uses and waste of energy.

Reference: Energy Conservation Activity Packet, Iowa Energy Policy Council and Dept. of Public Instruction, 1977. pp. 21,22,32.

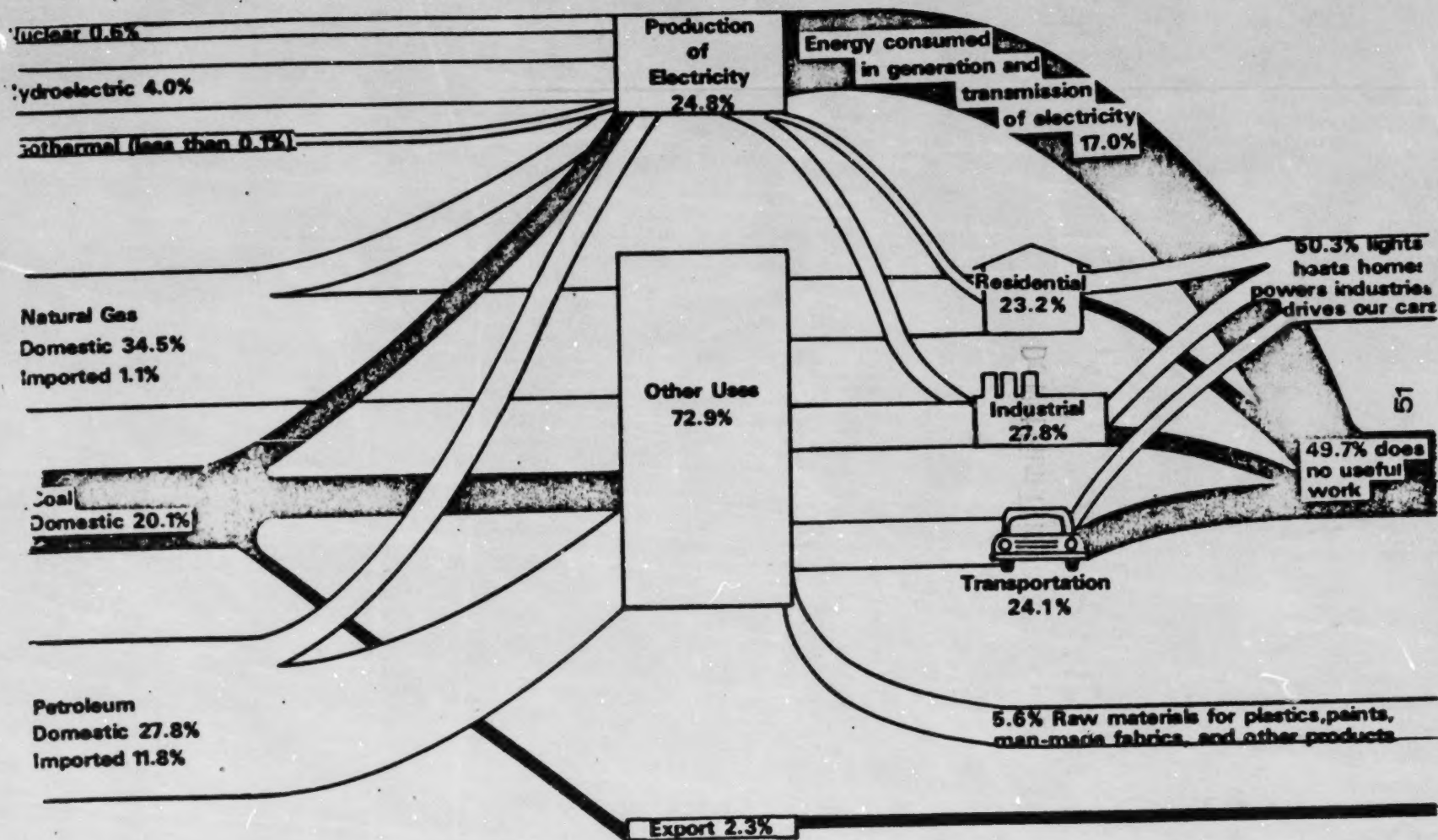


Fig. 1. Energy "Spaghetti"

#5

Activity Title: "Electricity: Our Energy Slave"Background:

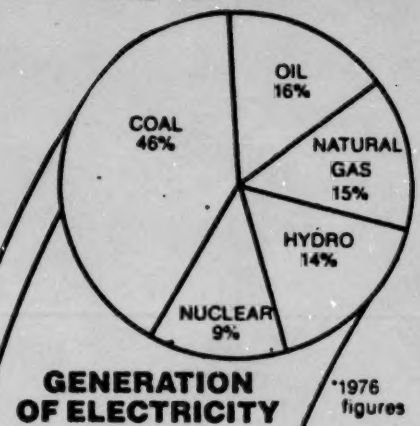
About 25 percent of the U.S. fuel budget is involved in the generation of electricity. Electricity is a secondary form of energy. It must be created by moving water (dams or waterfalls), by burning fossil fuels or by a nuclear reaction to create steam in a generator. Electric current is formed and flows in transmission wires to locations of use. Electricity is not a very efficient form of energy; about 2/3 of the potential energy is lost from source to user.

Time Required: 15 minutesMaterials: Spirit master, Fig. 1.Procedure:

1. Make a spirit master of Fig. 1 and distribute.
2. Give students these directions:

To see how the use of electricity has increased over two generations (50 years), check the appliances that your family uses now; then check those which you think your parents used when they were children; and which your grandparents used when they were children.

3. Discuss responses.
4. Tell your students that if they had lived in the year 1900, they would have used only one-fourth of the energy they use today. In the year 2000, they would use almost twice as much as they use today if demand continues at the present rate. What will happen if demand increases?



ITEM	avg. kwh per mo.*	your family	parents	grandparents
Dishwasher	35			
Microwave Oven	16			
Electric Range	98			
Blender	1			
Can Opener	1			
Electric Clock	1			
Automatic Coffeemaker	8			
Toaster	3			
Slow Cooker	12			
Refrigerator	152			
Vacuum Cleaner	4			
Clothes Washer	9			
Clothes Dryer	80			
Space Heater	75			
Water Heater	400			
Color TV	55			
B&W TV	30			
Radio-Record Player	9			
Power Saw	4			
Electric Blanket	12			
Hair Dryer	10			
Electric Toothbrush	1			
Room Air Conditioner	72			
Electric Fan	12			
Electric Furnace	1100			
Yard Light	30			
Garage Door Opener	1			

Fig. 1. The Increasing Use of Electricity

Reference: U.S. Dept. of Energy, Your Energy World, 1978.

HOME ECONOMICS

DAY II ACTIVITIES

TRANSPORTATION

You will need to choose approximately 30 minutes of support activities from the following list.

Objective:

Students will understand the impact of dwindling petroleum reserves on transportation fuel costs and life styles.

#1

Activity Title: "Out of Gas!"Background:

Severe limitations in the availability of gasoline supplies would wreak havoc with our society, especially if mass transportation modes were not developed. But, if this country were to face a permanent gasoline shortage tomorrow, what alternatives would we have?

Time Required: 20 minutesMaterials: ChalkboardProcedure: In an open class discussion ask students to consider the following:

Given the prospect of a permanent gasoline shortage, students will select from several alternatives (suggested by them and listed on the chalkboard), one they would prefer and defend.

The alternatives might include:

- a. Rationing one automobile per family.
- b. Limited allocations to stations or states.
- c. No government interference.
- d. Raising gas prices - taxing gas.
- e. Banning big cars, trucks, campers, travel homes, etc.
- f. Taxing automobiles by weight and horsepower.
- g. Banning all recreational vehicles, motorcycles and snowmobiles.

Reference: Energy Conservation, Energy & Man's Environment, 1977. p. 98.

#2 Activity Title: "What's the Best Way?"

Background: Any food product requires multiple energy investments. The further we are from our food source in distance and time, the greater the indirect energy investments.

Time Required: 20 minutes

Materials: Chalkboard, U.S. map

Procedure:

1. Copy Table 1 onto chalkboard.
2. Ask students to select one food which must be shipped to Colorado from another state.
3. Locate its geographical origin on a map and determine the various methods of transporting the product to your city.
4. Determine the most and least efficient method of transportation.
5. Discuss the net energy concept in relation to transportation. For example, a pipeline is an efficient way to transport fuel, but the construction of the pipeline itself may cost a considerable amount of energy.

Table 1.

Energy Efficiency of Freight Transport	
METHOD	KILOCALORIES* CONSUMED/TON/MILE
Railroad	167
Waterway (ship, barge)	170
Truck	950
Airplane	10,500

(Source: E. Hirst, Oak Ridge National Laboratory as quoted in Project Learning Tree Curriculum Guide.)

* Ordinarily, transportation energy ratings are given in B.T.U.'s per mile (British Thermal Unit). For the purposes of comparing energy values of transportation to the food we eat, the B.T.U.'s have been converted to kilocalories (Calories). Thus the airplane which consumes 42,000 B.T.U.'s per ton/mile may be said to use 10,500 kilocalories per ton/mile. Human beings "burn" between 2,000 and 3,500 kilocalories (food Calories) per day.

Reference: Adapted from Project Learning Tree, The American Forest Institute, Inc., Washington D.C., 1975.

#3

Activity Title: "The Short Trip"

Background:

Americans like to use their automobiles. In fact, 54 percent of all car trips in this country are less than five miles. Doesn't that seem unnecessary when frequently we could use public transportation, a bicycle, or walk? Interestingly enough- traveling on family business - going to the doctor or dentist or going shopping - accounts for 31.4 percent of all passenger car trips and averages 5.5 miles one way.

What would happen if each family took one less trip a week- e.g., seven instead of eight - by planning ahead to combine errands and appointments so that the car did not have to be used that one time? An average family would save \$74 a year. This may not be impressive enough on a family scale to some, but if every family did this we would save nationwide:

- 38 billion miles of driving
- 2.9 billion gallons of gasoline
- more than 1.5 billion dollars.

Time Required: 30 minutes

Materials: None

Procedure:

1. Review with the class the background material above.
2. Ask each student to make a list of typical short trip "destinations" his family makes in an average week.
3. Ask students to give reasons for the excessive number of short trips taken per week by his family.
4. Each student should then plan a daily "trip schedule" which conveniently combines many of the short trips into a few consolidated

C
excursions.

5. Assuming an average of 11 miles (round trip) per short trip, how many miles could be saved in one week? In one year?

Reference: Citizen Action Guide to Energy Conservation, Citizen's Advisory Committee on Environment Quality, 1700 Pennsylvania Avenue, N.W., Washington, DC 20006.

#4

Activity Title: "Feeding Your 'Dream Machine'"

Background: Suppose students could buy any new car they like - money being no object. What kind would they choose? They should keep one thing in mind, however: after they "buy" their "dream car", they have to be able to pay for the gas, oil, repairs, insurance and license fees. This activity asks students to consider gasoline costs only.

Time Required: 20 minutes

Materials: Overhead projector

Scratch paper

Procedure:

1. Make a transparency of Fig. 1.
2. Have students make their selections of their future "Dream Machine", noting EPA-rated mileage figures.
3. Now ask them to calculate the following:
 - a. Using 12,000 miles per year as an average and the EPA-rated mileage of your "Dream Machine", find how many gallons of gasoline would be consumed in one year.
 - b. At current costs of 95¢ per gallon, compute the annual cost of "feeding" your "Dream Machine".
 - c. Compute the annual gasoline cost when gasoline prices are raised to \$1.25/gallon.

Reference: Adapted from "Transportation and the City", NSTA PEEC, 1976, pp. 3,17.

Fig. 1

YOUR DREAM MACHINE

Model	Manu facturer	MPG
Chevette	GM-Chevrolet	31
Civic	Honda	32
Corolla sedan	Toyota	28
Datsun B-210	Nissau	29
Super Beetle	Volkswagen	26
Fiat 128	Fiat	24
VW Stationwagon	Volkswagen	28
Opel (Isuzu)	Isuzu	27
Vega	GM-Chevrolet	25
Dodge Colt	Mitsobishi	28
Pinto	Ford	28
Mazda RX-3	Toyo Kogyo	23
Mustang II	Ford	27
Datsun 280Z	Nissau	20
Volvo 244	Volvo	20
Gremlin	American Motors	21
Maverick	Ford	25
Volare	Chrysler-Plymouth	20
Nova	GM-Chevrolet	20
Torino	Ford	15
GTO	GM-Pontiac	16
Trans Am	GM-Pontiac	16
Matador	American Motors	14
Cutlass Supreme	GM-Oldsmobile	17
Cougar	Ford	14
Ford	Ford	14
Buick Electra 225	GM-Buick	15
Plymouth	Chrysler-Plymouth	13
Silver Shadow	Rolls Royce	11
Chrysler	Chrysler-Plymouth	14
Bonneville	GM-Pontiac	15
Eldorado	GM-Cadillac	12
Buick Wagon	GM-Buick	13
Ford Wagon	Ford	13
Chrysler Wagon	Chrysler-Plymouth	11
Continental Mark IV	Ford	13
Toronado	GM-Oldsmobile	14
Grand Prix	GM-Pontiac	16
Thunderbird	Ford	13
Mercedes 280 SEL	Daillier-Benz	16
Seville	GM-Cadillac	17

*1976 Gas Mileage from EPA City/Highway test cycle

Source: "1976 Gas Mileage Guide for New Car Buyers", U.S. Environmental Protection Agency, January, 1976. (second edition)

#5

Activity Title: "Dragging Suitcases"Background:

To conserve energy, it is evident that one must accomplish a task with the minimum amount of work. This principle was discovered many years ago when man first invented the wheel. He discovered it required less force and, consequently, less work, to roll an object than to drag it. In the process of doing work, the less resistance, drag or friction one must work against, the less energy is expended.

Loaded luggage racks increase air resistance of a moving automobile. Placing luggage inside the car can increase mileage.

Time Required: 20 minutes

Materials: Chalkboard

Procedure:

1. Copy the following problem on the chalkboard.
2. Solve it with students.

Problem

Suppose your car averages 25 miles per gallon of gasoline on long trips when the suitcases are on a luggage rack on top of the car. If by putting the luggage in the car (reducing air friction) you get 8 percent better mileage,

- a. Compute the number of miles per gallon your car would obtain with the luggage in the car.
- b. Compute the number of gallons, to the nearest tenth, you would use traveling from Grand Junction, Colorado, to Denver, Colorado, (258 miles), with the luggage:

1. on top of the car

ii. in the car.

c. assuming a cost of 95¢ per gallon for gasoline, determine the money you would save by packing the luggage in the car instead of on the roof on your trip to Denver.

Reference: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. pp. 8-9.

HOME ECONOMICS

DAY III ACTIVITIES

HOME ENERGY

You will need to choose approximately 30 minutes of support activities from the following list.

Objective:

The student will be able to understand the major energy expenditures involved in maintaining a comfortable home environment.

#1

Activity Title: "Luke Warm"

Background: The water heater is the second largest energy eater in your home, consuming about 15% of household energy (excluding transportation) and representing 9¢ of every total energy dollar. The amount of energy (and dollars) spent on maintaining a supply of hot water varies with family size and water use habits. It's important to use hot water conservatively.

Time Required: 20 minutes

Materials: Chalkboard/overhead projector

Procedure:

1. Copy Tables 1 and 2 onto chalkboard or transparency.
2. Discuss Table 1 with students.

- a. Have them estimate number of gallons of hot water used per day in the average 4-member family.
- b. Ask students to calculate how many gallons of hot water would be used typically in 365 days. (Assume that hot water is approximately 60% of the total water consumption when hot and cold are used together, as in bathing.)
- c. Students (using Table 2) should then calculate:
 - i. the number of kilowatt hours an electric water heater would consume in heating the number of gallons (from b) to normal washing temperature in one year.
 - ii. the number of cubic feet of natural gas required (as in i) for a gas water heater.
 - iii. the estimated operation cost per year of one electric water heater.
 - iv. the estimated operation cost per year of one gas water heater.

Reference: Adapted from: Water Conservation and Wasteflow Reduction in the Home. Special Circular 184. Used with permission of the Pennsylvania State University, College of Agriculture, Extension Service and the Institute for Research on Land and Water Resources, University Park, Pa.

Table 1.

HOW WATER IS USED BY A
TYPICAL AMERICAN FAMILY OF FOUR

<u>USE</u>	<u>Gallons Used Per Day</u>
Dishwashing	15
Cooking, Drinking	12
Utility sink (washing hands, etc.)	5
Laundry	35
Bathing	80
Bathroom sink	8
Toilet	<u>100</u>
Total	255

Table 2.

Gas and Electricity Needed to Heat
One Gallon Water to Normal Washing Temperature

<u>Source</u>	<u>Amount</u>	<u>Cost Per Unit</u>
Gas	1 cubic foot	.0014¢
Electricity	.25 kilowatt hour	4.5¢

#2

Activity Title:

"Raise It 'n' Lower It"

Background:

Space heating and cooling is the greatest single energy user in the home. It accounts for 41% of our total personal energy consumption. Therefore, our heating and cooling systems offer the greatest opportunities to save energy. Raising and lowering thermostat settings to reflect use patterns of your home and variations in seasons can save energy dollars.

During the heating season, set your furnace thermostat to 65°F during the day if your home is occupied, 60°F or lower at night and while the building is unoccupied. Each degree of thermostat setting reduction can save up to 3% of your heating bill.

During the cooling season, set your air conditioner's thermostat to 78°F or restrict usage, utilizing natural ventilation and/or circulating fans. You can save up to 4% per degree set - forward on the cost of cooling your house. While away from home, turn your air conditioner off.

Time Required: 10 minutes

Materials: Chalkboard

Procedure:

1. Copy Table 1 onto chalkboard.

Table 1.

This table estimates possible savings in energy resulting from lowered nighttime thermostat settings during the entire heating season.

<u>Night Temperature Setting</u>	<u>Percent Savings</u>
70°F	0%
65°F	5%
60°F	10%

2. Read the following paragraph to students:

"Last January, the Browns kept their daytime and night time thermostat set at 70°F (21°C) for the entire month. Their heating bill was \$110. In February, they set back the thermostat to 60°F (15.6°C) from 10:00 p.m. to 6:00 a.m."

Help students answer these questions:

- a. If January and February were equally cold months and if there was no increase in fuel costs, estimate how much money they saved in February.
- b. If the savings in (a) was average for four winter months, how much heating money could have been saved from December through March?

Reference: Energy Information Associates, Inc., 2690 W. Main Street,
Littleton, Colorado 80120

#3

Activity Title: "Up the Chimney"

Background:

Most fireplaces are energy losers. A large volume of air, conditioned by the home furnace, can be drawn to the fireplace by convection and expelled through the chimney. Fireplace dampers and/or special heat-tempered doors can be used to minimize this loss of heat energy and dollars, as can reducing your furnace thermostat setting and closing doors to other areas of the home when using your fireplace.

Some fireplaces were designed to reduce the loss of furnace heat. These are provided with outside air ducts or pipes (and dampers), and do not use inside air for combustion.

A "rule of thumb" to remember: If the outdoor temperature is colder than 35°F (2°C), a roaring fire will cause your furnace to cycle on more frequently than normal - and your energy dollars go up the chimney!

Time Required: 10 minutes

Materials: None

Procedure:

1. Ask students to respond to the following question:
"When does a fireplace cool your house?"
2. Discuss the answer using the Background information as a reference.

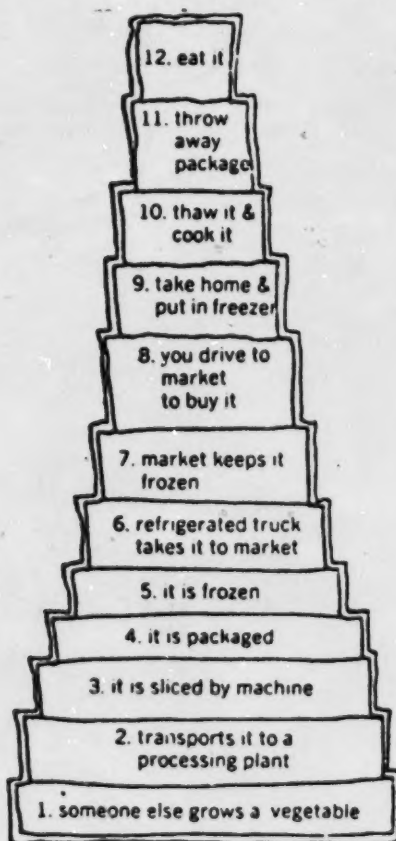
Reference: Energy Information Associates, Inc., 2690 W. Main Street,
Littleton, Colorado 80120

#4

Activity Title: "It Takes Energy to Eat"**Background:** Energy is consumed at every step in the preparation of food.**Time Required:** 20 minutes**Materials:** Chalkboard**Procedure:**

1. Ask students to list the energy steps involved in the preparation of a box of frozen spinach. List on the chalkboard (See Fig. 1 for an example.)

Fig. 1. Energy Steps in Preparation of
A Frozen Vegetable



2. Which steps could be eliminated to save energy?

Note: This type of visual representation makes a nice bulletin board display.

3. Have students plan and prepare a "low energy" meal.

Reference: Adapted from Energy Conservation in the Home, USDOE, 1977. p. 20.

#5

Activity Title: "It All Adds Up"

Background: The average four-member family in Colorado spends between \$1,900 and \$3,600 directly for energy each year. Since other goods and services which we purchase require energy for production and delivery, (much more money is spent indirectly for energy) -- and energy costs are escalating at 20 - 30% per year!

Time Required: 20 minutes

Materials: Overhead projector

Procedure:

1. Make a transparency of Table 1.
2. Cover the right-hand column with a strip of paper.
3. Ask students to estimate the annual costs of each item on the left.
Write a consensus of student estimates to the right of the paper strip.
4. Uncover the right hand column and compare student estimates with there data.

Reference: Energy Information Associates, Inc., 2690 W. Main Street,
Littleton, Colorado 80120

Table 1.

The table below indicates approximate energy costs for a typical four-member family living in Colorado. Although the costs vary with different living habits, the importance of focussing energy conservation on the big consumers is clear.

<u>Energy User</u>	<u>Approximate Annual Cost</u>
Automobiles, Each	\$2400
Furnace/Boiler	420 - 700
Water Heater, Each	\$168
Refrigerator/Freezer, Each	92
Cooking	100
Lighting	28
Color TV (4 hr per day), Each	28
Coffeemaker (once per day), Each	7
Window Fan (seasonal), Each	9
Radio (4 hr per day), Each	8
Vacuum Cleaner	4
Hair Dryer (1000 watts, daily, per person)	5
Toaster	3
Clock, Each	1
Mixer	.15
Shaver	.05
Can Opener	.04

HOME ECONOMICS

DAY IV ACTIVITIES

APPLIANCES

You will need to choose approximately 30 minutes of support activities from the following list.

Objective:

The student will be able to determine energy consumption, the associated costs of operating household appliances and will be able to assist in the energy efficient management of his own household.

#1

Activity Title: "How Much Did You Use?"

Background: By examining your gas and electric bill and using some simple mathematics, you can calculate not only the rate you pay, but the amount of energy you're using as well.

Time Required: 20 minutes

Materials: 1. Transparencies of Figs. 1 & 2

2. Overhead projector

3. Chalkboard

Procedure:

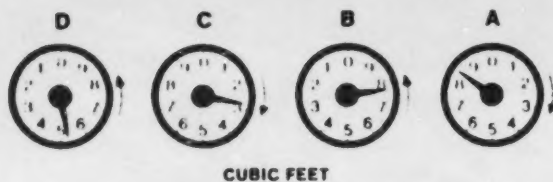
1. Project Fig. 1. "How to Read Your Gas Meter"

2. Illustrate process with a pair of "dials" drawn on chalkboard. Subtract two "readings" to determine consumption.
3. Project Fig. 2. "How to Read Your Electric Meter"
4. Repeat Step 2.
5. Call Public Service Company of Colorado to check availability of free meter dials for use with this activity.

Reference: Adapted from Your Energy Budget Manager, Public Service Company of Colorado.

HOW TO READ YOUR GAS METER

HE-34



CUBIC FEET

The main thing to remember when reading your gas (or electric) meter is that until the dial pointer has passed a number, it is always read as the lesser number. For example, in dial "A" (see illustration) the pointer is between the numbers 8 and 9. Therefore, the reading on that dial is 8.

A gas meter consists of 4 dials, the dial on the far right (A) registering hundreds of cubic feet, dial (B) thousands of cubic feet, dial (C) tens of thousands of cubic feet and dial (D) hundreds of thousands of cubic feet.

Using the illustration above, we have already determined that the reading on dial A is 8. Dial B is almost at 8 but has not yet passed it so the reading on this dial is 7. Dial C's pointer has not yet passed 3 so the reading here is 2, while dial D is 5. The reading on this meter is then written as 5278.

Let's assume the reading on your last month's bill was 4951. By subtracting 4951 from 5278 you find the difference is 327. To get the true reading, you must add two zeros to this number because the last number is actually hundreds of cubic feet. The meter tells you, therefore, that you have used 32,700 cubic feet of natural gas since the last time you checked it.

Fig. 1

HOW TO READ YOUR ELECTRIC METER



KILOWATT-HOURS

Fig. 2

Reading an electric meter is much the same, except you are measuring kilowatt-hours. However, the reading you arrive at represents the actual number of kilowatt-hours consumed. There is no need to add the two zeros to your total figure.

Again, using the illustration and reading the dials as before, this meter shows a reading of 9484 kilowatt-hours. Assume your last month's reading was 8750. Subtracting one from the other, you find that you have used 734 kilowatt-hours in that period of time.

#2

Activity Title: "Which Costs the Most?"

Background: Due to the different power requirements (watts) of household appliances, some cost more to operate per hour than others.

Time Required: 30 minutes

Materials:

1. Worksheet #1
2. Overhead projector
3. Chalkboard

Procedure:

1. Make a spirit master of Fig. 1.
2. Make a transparency of Table 1.
3. Explain the concept of a "mill" (.001 of a dollar)
4. Ask students to choose 10 appliances they "need" in their homes.
5. Instruct them to plot a histogram of the cost per hour vs. the ten appliances, using Fig. 1.
6. Make a "class data" composite histogram on the chalkboard listing the ten most expensive appliances per hour of operation.
7. How could money and energy be saved in the future use of each appliance?

Reference: Adapted from Energy Activities for the Classroom, ERIC Center for Science, Mathematics, and Environmental Education, College of Education, The Ohio State University, 1976. pp. 23-24.

Table 1.

COST OF ELECTRICITY FOR ONE HOUR OF USE

1.	Toothbrush	\$.0002 (.02 of a cent)
2.	Toaster	.04
3.	Hot Water Heater:	
	Tub Bath	.09-.14
	Shower	.07-.115
	Automatic Washer	.17
	Dishes by Hand	.02
	Dishwasher	.09-.14
4.	Freezer	.005 ($\frac{1}{2}$ cent)
5.	Lights:	
	Incandescent - 100 watt	.0038
	Fluorescent - 40 watt tube ..	.0019
6.	Record Player	.004
7.	Air Conditioning	.038
8.	Radio	.002
9.	Television:	
	Black and White:	
	Solid State	.002
	Tube	.006
	Color:	
	Solid State	.007
	Tube	.01
10.	Range:	
	Large Burner	.038
	Small Burner	.02
	Bake	.02
	Broil	.13
11.	Dishwasher	.045
	Hot Water	.14
12.	Refrigerator/Freezer - 14 cu/ft:	
	Frostless	.008
	Manual	.005
13.	"Radar" Range - Microwave Oven ...	.05
14.	Clock	.007

HE-37

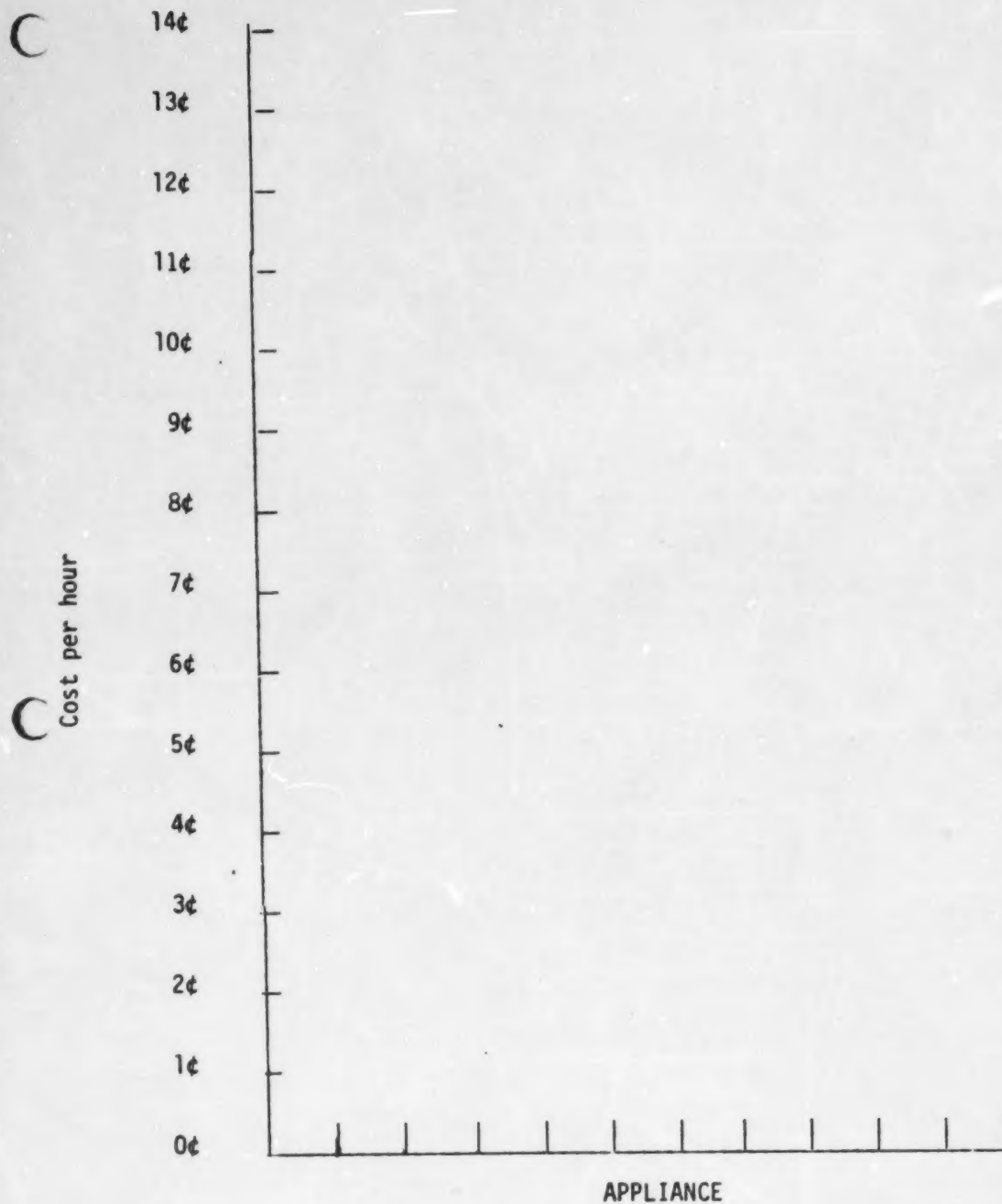


Fig. 1.

#3 Activity Title: "What's For Dinner?"

Background: Wise food choices can save energy and money.

Time Required: 30 minutes

Materials: Spirit masters of "Energy Menu" and "Energy Prices"

Procedure:

1. Distribute "Menus" and "Prices" to students.
2. Read the following instructions:

Review the items offered in the Menu on the following page and select your "first preferences" based strictly on likes and dislikes. Place checks beside those items in Column 1. Next, make selections from the menu on the basis of least energy consumption. Remember, the energy cost of a food includes: fertilizers and insecticides, equipment; transportation; processing, packaging, and preparation. Place a check by each "low energy" item selected in Column 2. Then refer to the Energy Price List for each item's Energy Cost. Indicate the "price" of each item you chose and determine your total bill. To discover how you might have saved energy, find the differences between the individual items in the two columns and enter those figures in Column 3. The differences will be losses or gains in costs. Add the total "pluses and minuses" in this column to find total energy savings. If you were to select items for Column 1 (preferences) again, would your choices be any different?

3. Have students complete their "Energy Menus".
4. Discuss the energy and dollar implications of wise food decisions.

Reference: Adapted from Energy Conservation In the Home, USDOE, 1977.
pp. 211-213.

ENERGY MENU			
	1 FIRST PREFERENCE	2 LEAST ENERGY	3 DIFFERENCES (+ or -)
APPETIZERS (CHOOSE ONE FROM EACH PAIR)			
Frozen Juice	— \$ —	— \$ —	— \$ —
Fresh Juice	— — —	— — —	— — —
Crackers (unwrapped, available to the restaurant in bulk)	— — —	— — —	— — —
Crackers (wrapped indi- vidually, packed in small cartons)	— — —	— — —	— — —
Butter	— — —	— — —	— — —
Margarine	— — —	— — —	— — —
MAIN DISH (PLEASE MAKE A FIRST AND SECOND CHOICE AS WE DO NOT ALWAYS CARRY EACH ENTREE)			
Luncheon Meat	— — —	— — —	— — —
Chicken	— — —	— — —	— — —
Turkey	— — —	— — —	— — —
Rice with Vegetables	— — —	— — —	— — —
Beef (grass-fed)	— — —	— — —	— — —
Beef (grain-fed)	— — —	— — —	— — —
VEGETABLE (SORRY, TODAY WE HAVE ONLY CARROTS, BUT YOU MAY CHOOSE YOUR PREFERRED TYPE)			
Fresh Carrots	— — —	— — —	— — —
Dehydrated Carrots	— — —	— — —	— — —
Frozen Carrots	— — —	— — —	— — —
Canned Carrots	— — —	— — —	— — —
DRINKS (PLEASE CHOOSE A FIRST AND SECOND CHOICE AS WE SOMETIMES RUN SHORT OF ONE KIND OF DRINK AT LUNCH)			
Soft Drink (in aluminum can)	— — —	— — —	— — —
Soft Drink (in returnable glass bottle)	— — —	— — —	— — —
Milk	— — —	— — —	— — —
Beer (in aluminum can)	— — —	— — —	— — —
Beer (in returnable glass bottle)	— — —	— — —	— — —
DESSERT: CHOOSE ONE			
Apples (homegrown in our restaurant's own garden)	— — —	— — —	— — —
Apples (store-bought)	— — —	— — —	— — —
Walnuts (shelled)	— — —	— — —	— — —
Walnuts (unshelled)	— — —	— — —	— — —
Ice Cream	— — —	— — —	— — —
TOTAL BILL — — —			

ENERGY PRICES

(Prices are proportional to actual energy expenditure)

APPETIZERS:

Fresh Juice: 12¢

Frozen Juice: 46¢

(Freezing and processing use a great deal of energy, both initially and for storage)

Cracker A: 10¢

Cracker B: 15¢

(Food excessively packaged or only available in small packages is more energy-intensive than unwrapped foods or foods available in bulk)

Butter: 15¢

Margarine: 5¢

MAIN DISH:

Luncheon Meat: \$1.60

Chicken: .96

Turkey: 1.06

Rice with

Vegetables: .45

Beef (grass-fed) 1.48

Beef (grain-fed) 2.08

(Animals are inefficient converters of protein. A pound of meat requires about four times the energy to produce and market as a pound of vegetable protein. Some animals are more efficient converters of protein than others.)

VEGETABLE:

Fresh Carrots: 12¢

Dehydrated Carrots: 92¢

Frozen Carrots: 31¢

Canned Carrots: 23¢

(Processed vegetables require more energy than fresh vegetables; freezing and dehydration especially require large amounts of energy.)

DRINKS:

Soft Drink (aluminum can): 45¢

Soft Drink (returnable bottle): 31¢

Milk: 34¢

Beer (aluminum can): 50¢

Beer (returnable bottle): 25¢

DESSERT:

Homegrown apple: 3¢

Store-bought apple: 19¢

(Homegrown apple by commercial methods saves commerce and transport; organic methods would save more.)

Walnuts, shelled: \$1.04

Walnuts, unshelled: 39¢

Ice Cream: 60¢

(Large quantities of milk are used; freezing is necessary.)

#4

Activity Title: "Apples, Steers and Corn"

Background: Agriculture and beef production are very energy intensive. Some foods are produced with greater energy efficiency than others. Net energy can be determined by contrasting energy input with energy output.

Time Required: 20 minutes

Materials: Spirit master of Worksheet #1.

Procedure

1. Make a spirit master of Worksheet 1.
2. Help students work through the energy/food problems.

Reference: Energy Activities for the Classroom, ERIC Center for Science, Mathematics, and Environmental Education, College of Education, The Ohio State University, 1976. p. 155.

Worksheet 1

Definitions:

1 Btu is the amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit.

1 Calorie is the amount of heat needed to raise the temperature of one kilogram of water one degree Celsius.

1 Calorie = 4 Btu's

1. If it takes 1487 Calories of energy to bring one pound of apples from the orchard to the store and one pound of apples provide your body with 263 Calories, how many more Calories are used to transport the apples than are actually contained within the apples?

2. If it requires 7,412 Calories to produce one pound of beef from steers that are grass-fed and 10,650 Calories to produce one pound of beef from steers that are grain fed, how many times more energy does it take to produce grain-fed beef than forage-fed beef?

3. <u>Btu's/lb. to produce:</u>	<u>Calories/lb. available to body:</u>
fresh corn kernels - 5,250	376
canned corn kernels - 10,300	372
frozen corn kernels - 12,750	372

Using the figures above, calculate:

- How many more production Calories does frozen corn require per pound than fresh corn?
- How many more Calories does your body receive from a pound of fresh corn than from a pound of canned corn?

c. Efficiency = $\frac{\text{Calories/pound available to body}}{\text{Calories/pound to produce}}$ or in other words,

how many Calories of energy does your body receive for every Calorie that went into producing the corn? Determine the efficiencies of fresh, canned, frozen corn.

#5

Activity Title: "Home On the Range"

Background: The kitchen range and oven are other large users of energy which afford us an opportunity to conserve our fossil fuels.

Time Required: 15 minutes

Materials: None

Procedure: Ask students how each of the following techniques can save energy dollars:

1. Avoid opening the oven door to check the cooking progress.
2. Whenever possible, defrost frozen foods in the refrigerator before cooking.
3. Use a microwave oven to defrost frozen foods, to reheat or to cook certain foods.
4. Use a cooking pot or pan which matches the size of the heating element.
5. Periodically clean the reflector pans under the cooking elements.
6. Use a small "toaster" oven whenever the large oven cannot be utilized to its maximum capacity.
7. Avoid excessive use of the kitchen range exhaust fan on cold winter days.
8. Turn off electric heating elements 1 - 3 minutes before cooking is completed.
9. When steaming vegetables and the water begins to boil, reduce the temperature setting to "simmer".
10. When boiling water for tea or instant hot drinks, use a tea kettle, not a pan.

Reference: Energy Information Associates, Inc., 2690 W. Main Street,
Littleton, Colorado 80120

DAY V ACTIVITIES

FUTURE ENERGY

You will need to choose one culminating activity from the following list.

Objective:

The student will understand the physical and social importance of energy conservation in reducing household energy expenditures and in "buying time" for the development of alternative sources of energy.

#1

Activity Title: "Conservation Award of the Year"

Background: This activity can serve as a summary of the mini-unit.

Time Required: 15 minutes

Materials: None

Procedure:

Ask students to assume they are in a position to give a homeowner in their community an award of \$1,000 for energy conservation:

1. What energy conservation features would you look for on the exterior of the home?
2. What energy conservation features would you look for on the interior of the home?

3. How does a homeowner's lifestyle contribute to energy conservation?

Reference: "Energy Conservation", Energy & Man's Environment, 1977. p. 77.

#2

Activity Title: "Lead Time"

Background: Presently, most of our energy requirements are met with fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed. But this takes time - often 5 - 10 years from drawing board to on-line operation.

Time Required: 15 minutes

Materials: Overhead projector

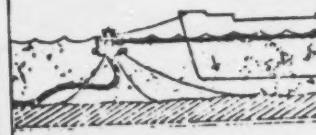
Procedure:

1. Discuss with the class the idea of the U.S.A. becoming more independent in petroleum supplies.
2. Introduce, with a transparency made from Fig. 1 below, the concept of "lead time".
3. Emphasize that in the oil industry planners must think in terms of several years, not just a few months.
4. Lead times for development in other energy areas are:

Coal Mines:	8 - 10 Years
Nuclear Power Plants:	10 - 15 Years
Geothermal:	7 - 10 Years
Fusion:	25 - ? Years
Shale:	8 - 10 Years
Solar Photovoltaic:	10 - 40 Years

Reference: A Teacher's Handbook on Energy, Colorado Department of Education, Denver, Colorado 80203.

Fig. 2.

Lead Times in Oil Industry Developments.	
Geophysical work to find commercial field 1-3 years	
Offshore drilling 1-2 years to drill wells 6-18 months to set platforms 2-3 years in development	
Refinery Construction 3 years to obtain site, to design, and to get permits 2-4 years for construction	
Marine Terminals 3 years upwards	
Tanker construction 2-3 years	

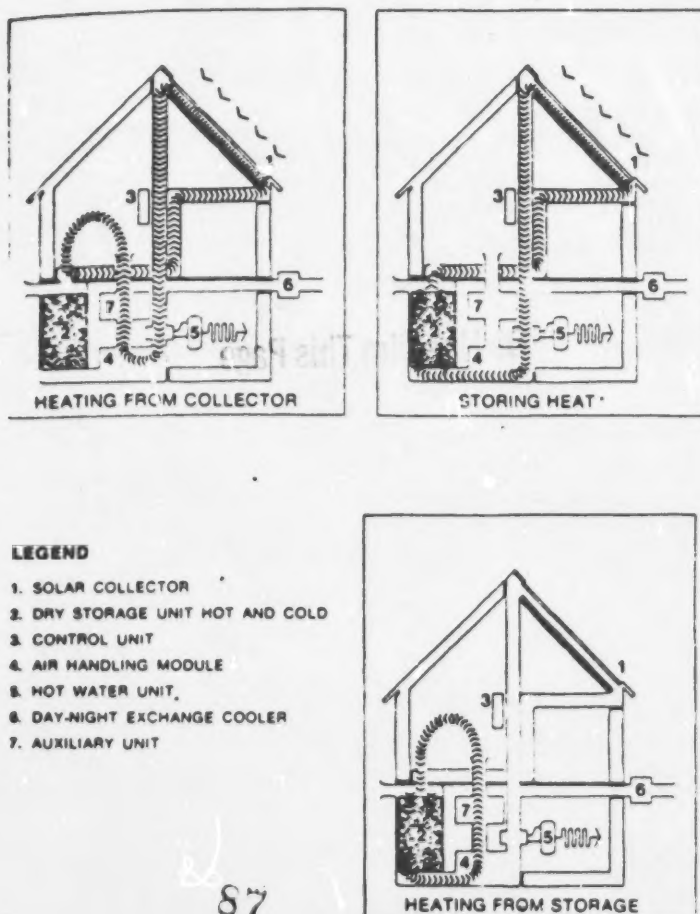
Courtesy of Shell Oil Company

#3 Activity Title: "Harnessing The Sun"

Background:

There are several ways to use solar (sun) thermal energy. One way is for each house, apartment, school or office building to collect enough solar heat to satisfy a large portion of its own space heating and cooling and water heating needs, but not its electric power, (Fig. 1.). Another is to build vast solar "farms" to collect solar energy, convert it into heat and then into electricity that would be sent to individual dwellings. A one-square mile farm of many of these collectors could supply electricity for about 20,000 houses.

Fig. 1. Typical Air System



In these drawings, (1) is the air-type solar collector. It consists of a flat steel absorber plate painted black with special high absorbtivity paint, covered by two sheets of double-strength glass, spaced approximately 3/4 inch apart. This cover traps the long waves of infrared solar radiation radiated glassward by the absorber plate, preventing this heat energy from radiating back into the atmosphere.

Under the absorber plate is 1/2 inch of air space. Below the air space is a blanket of two or more inches of insulation (fiberglass or rock wool) fastened to the sheathing of the roof and to the bottom of the collector panel.

As indicated in Figure 1, air from the rooms of the house is forced upward, through the 1/2-inch space between the hot absorber plate and the insulation. When the house and storage bin (2) are cold, warm air from the collector is transported by ductwork back into the rooms. This procedure is controlled by a differential thermostat (3).

When the rooms are adequately warm, the hot air from the collector panel is directed to the heat storage bin (2), filled with clean dry pebbles or small rocks.

During cold periods when the sun is obscured and no direct solar energy can reach the collector, or at night, warmth can be drawn from storage bin. The capacity of the storage bin should be designed to provide the heating needs of a six-room house for two or three days in cold cloudy weather.

All heat storage and distribution is controlled by the thermostatic unit labeled (3). This control system is designed to establish and maintain comfortable temperatures in any weather and responds to temperature

inputs provided by sensors located at appropriate points in the heating system.

All the elements of the air-handling module, including connecting ducts, air filters, blowers, and automatic dampers, which cut off the air flow from a room when the thermostat registers the desired temperature, can be placed in the basement (4). Usually this module is placed next to the pebble storage bed. In a house without a basement, the same effect can be achieved by locating units (2), (4), (5) and (7) in a utility room, or in an insulated shed near the house outside.

The object labeled (5) is a solar hot water unit (consisting of an air-to-water heat exchanger and a preheat storage tank) which is plumbed to a conventional water heater (7). The auxiliary heater consumes fuel only when the solar panel was unable to heat the water to the desired temperature.

The object indicated by (6) is a day-night exchange cooler. This space cooling system is usually inexpensive and quite effective if the entire system is properly designed.

Because no solar heating system can be built economically to provide 100% of a home's space heat and hot water needs, the auxiliary heater (7), is required. Although it is possible to design a solar heating system to provide 100% of the load, the cost would be prohibitive because the heat storage bin would have to be quite large to provide heating needs through one or two weeks of cold cloudy weather.

Time Required: 15 minutes

Materials: Spirit master of "Solar Energy"

Procedure:

1. Sketch Fig. 1 on the chalkboard. Explain functions of the 7 labeled items, using background information.
2. Make a spirit master of the "Solar Energy" worksheet on page HE-53.
3. Discuss the diagram and the answers to the set of six questions.
4. Optional (40 minutes):

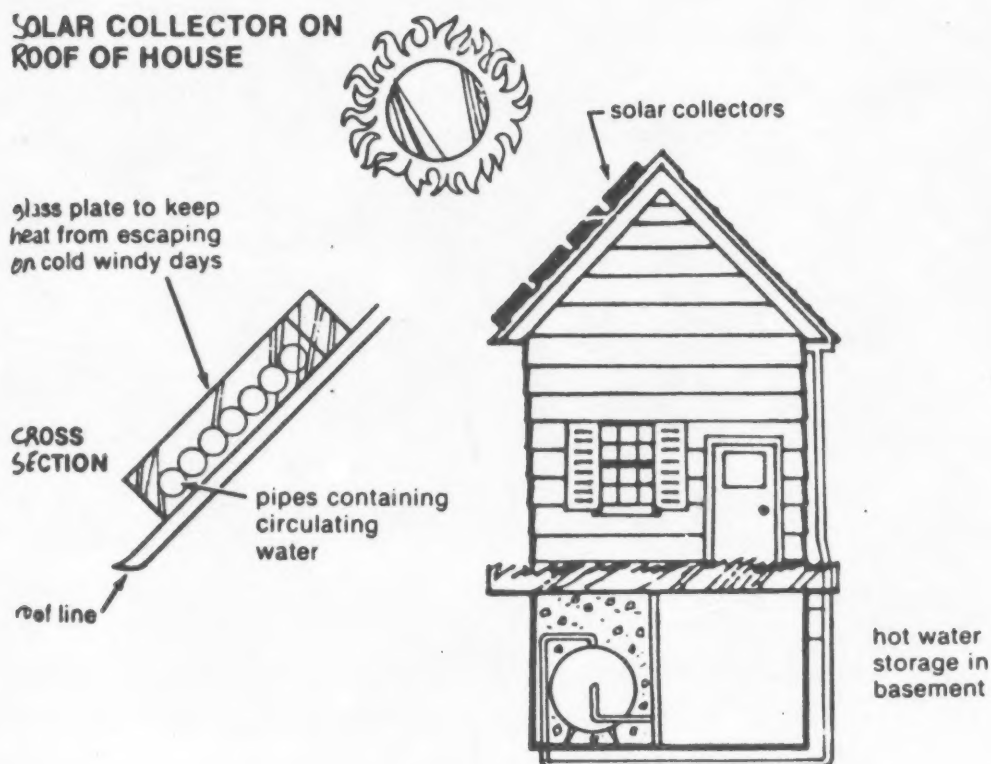
Ask students to work in teams to design on butcher paper a house and its solar heating system which uses the following:

- a. Air collector.
- b. Rock storage bin.
- c. Thermostat controls.
- d. Air blowers or fans.

Students should design their systems to a) heat the rooms directly from the collector, and b) heat the rooms using only the energy in storage (when the sun is obscured by clouds. Finally, ask each team to display and explain its design to the class.

Reference: Adapted from "Energy From the Sun", The Energy Challenge, FEA, 1976.

Background information and Fig. 1 adapted from Ted Lucas, How To Build A Solar Heater, Ward Ritchie Press, California, 1975, pp. 18-20.

Solar Energy**SOLAR COLLECTOR ON
ROOF OF HOUSE**

1. What parts of the U.S. would be able to use solar heat without a conventional back-up furnace?
2. On which side of the roof should the collectors be mounted?
3. Why is the inside of some types of collectors lined with mirrors?
4. Could the heat from roof collectors be used to generate electricity?
5. Could the heat from solar farm collectors be used to generate electricity?
6. The United States Department of Energy Administration foresees as much as 25 percent of our energy needs filled by solar technologies by the year 2020. Why will it take so long?

1

MATHEMATICS

M-1

DAY 1 ACTIVITIES

INTRODUCTION

Choose one, two or three activities from the following list, using them to introduce students to U.S. energy problems.

Objective

The student will be able to understand the root causes of the U.S. energy dilemma and the need to conserve energy fuels.

#1

Activity Title: "Entering A New Energy Era"

Background: America's growing economy has had a succession of primary fuels - first wood, then coal, now oil and natural gas - all in bounteous measure. Wood held sway until a tip point in the 1880's, when the country began consuming more coal than wood. Coal was king until 1950, when we began to derive more energy from petroleum than from coal. The switch was triggered not by a shortage of coal - which was and still is in abundant supply - but by the attractions of oil and natural gas. They were cleaner, easier to extract, transport and burn; for a variety of reasons, cheaper; and above all, versatile. By 1973, they provided 77 percent of our energy (46 percent from oil, 31 percent from natural gas). Since coal now accounts for only 18 percent, and "other" (hydropower and nuclear) for the other 5 percent, it is hardly inaccurate to say that America runs on oil and gas. This seemingly simple fact has had repercussions in almost every part of our society, from

family structure to patterns of community development to international relations. The shift to almost total dependence on these finite, nonrenewable sources took less than a hundred years.

By the 1970's, not only were imports of oil growing but U.S. production of oil and natural gas had actually begun to decline. Why? The answers lie in the economics of their production, in government action, in environmental concerns and ultimately in geologic facts. Fig. 1 tells the story.

Time Required: 15 minutes

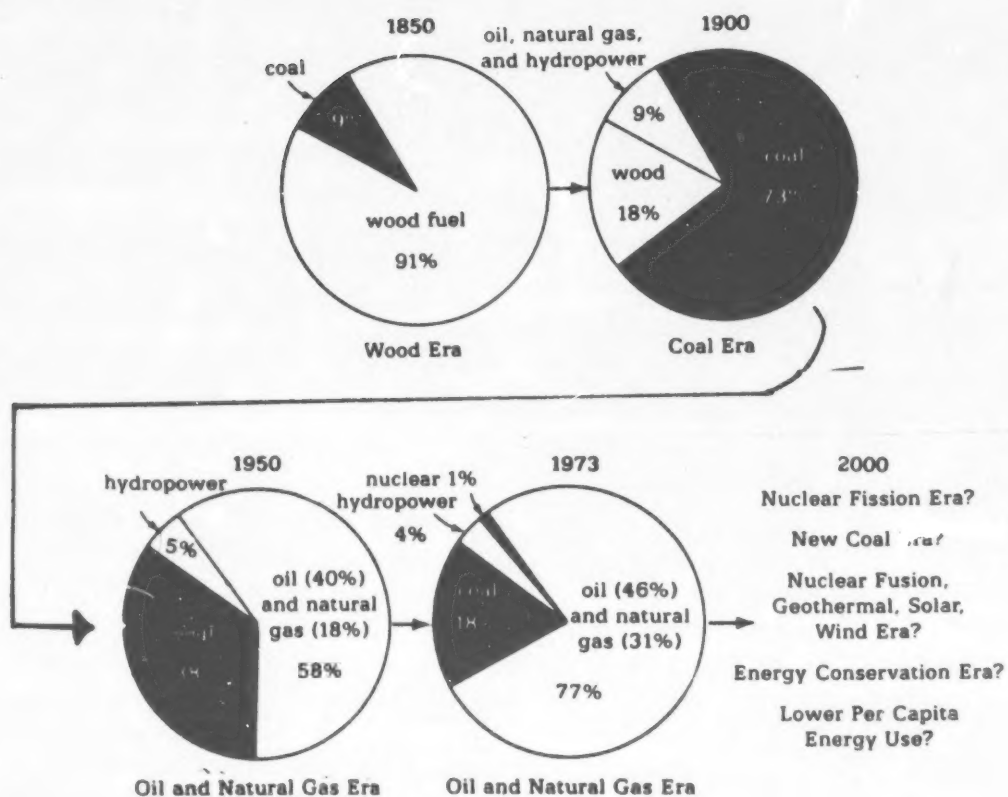
Materials: Overhead projector

Procedure:

1. Make a transparency of Fig. 1 and project for class consideration.
2. Ask students to interpret the diagram and to answer the following questions:
 - a. What three transitions are visible in Fig. 1?
 - b. Describe motivating reasons for each transition.
 - c. Why must we force a new transition from the non-renewable fossil fuels to a renewable base of energy fuel?
3. Have students draw a pie diagram depicting their visions of U.S. energy resource use for the year 2000. Discuss.

Reference: Adapted from Energy Dilemmas, League of Women Voters, Copyright, League of Women Voters Education Fund. (Order from League of Women Voters of the U.S., 1730 M Street, N.W., Washington, D.C. 20036; publication #688, \$1.00) 1977, pp. 6-7.

Fig. 1. Our Energy Eras



#2

Activity Title: "The Trouble with Exponential Growth"

Background: Exponential growth is geometric growth (on a pattern, for example, of 1,2,4,8,16), rather than arithmetic growth (on a pattern of 1,2,3,4,5). To put it another way, exponential growth is growth at a fixed percentage rate over time (a savings account at compound interest is a standard illustration).

The key to understanding the implications of exponential growth in population, in resource consumption or in pollution levels is to calculate the doubling time of a growing quantity. A handy rule of thumb is to divide the percent rate of such growth into the number 70 to arrive at the doubling time. For example, the population of the world, now roughly four billion persons, is growing at about 1.6 percent per year. The doubling time is 70 divided by 1.6, or 44 years. So long as that rate of growth holds constant, we can calculate the future population as follows:

	4 billion people in 1975
plus 44 years	8 billion people in 2019
plus 44 years	16 billion people in 2063

To say this another way, a child born in 1975 who lives 88 years will experience first hand what it is like to live in a world of 16 billion persons or will witness first hand what it was that intervened to forestall the 16 billions.

The U.S. growth rate for electricity consumption is illustrative. For much of the 20th century, it has been at 7 percent a year, doubling each decade ($70 \div 7 = 10$). This meant that, besides replacing obsolete facilities, utilities have had to double their usable generating capacity each ten years. Plotting this progression on a simple graph would give a visual idea of the

impact of such growth, if it were to continue for two more doubling times from 1970. In fact, many industry experts were predicting just such a growth rate, but since the embargo, consumption has moderated; the industry now projects somewhat slowed rates of growth.

This moderation in growth rate may also be illustrative of a general slowdown both of U.S. population growth and of growth in energy use. It is wise to keep in mind, however, that even lesser growth rates are exponential - that is, they do lead to doublings, even though the doubling time is lengthened.

The following exercise illustrates the arithmetic of doubling (exponential growth) and suggests there are limits to exponential growth of any quantity.

Time Required: 45 minutes

Materials: Dittoed checkerboard for each student

5 pounds rice

Procedure:

1. Give each student a checkerboard, some rice and directions to place one grain of rice in the lower left hand square, two grains in the next square, four in the next, eight in the next, 16 in the next and continue in this pattern. Have students estimate the amount of rice they will need.

When students realize they have run out of room and are faced with an impossible task, discuss these questions in class.

- a. Were you able to fill all the squares? If not, why not?
- b. How is the doubling of rice grains in the squares like our current consumption of energy?
- c. What will happen if we continue to consume energy at our present rate of consumption?

d. What factors affect this rate of consumption?

2. Discuss the game of "Rice Checkers". There are 64 squares on the board. If the number of grains of rice is doubled 63 times, that will be 2 to the 63rd power grains of rice on the 64th square. They would have to put more rice in the last square than there is rice in the whole world.

No one was able to complete game because he ran out of room.

The current consumption of energy is increasing at a rapid rate too.

3. Show students how to calculate doubling time, t_2 , using the following expression: $t_2 = \frac{70}{\text{annual \% growth rate}}$

4. Calculate t_2 for each of the following examples:

- a. Inflation (and electricity consumption) at 7% per year.
- b. Population at 1.64% per year.
- c. Energy consumption at 3% per year.

References:

1. Energy and/or Earth, Jefferson County Schools, 1978. pp. 87-88.
2. Energy Options, League of Women Voters, Copyright, League of Women Voters Education Fund. (Order from League of Women Voters of the U.S., 1730 M Street, N.W., Washington, D.C. 20036; publication #628, \$1.00), 1977. p. 7.

RICE CHECKERBOARD

#3

Activity Title: "Petroleum - What's Left?"

Background: Our petroleum age began in 1859 with the first successful oil well drilled at Titusville, Pennsylvania. By the time of the embargo and the OPEC price squeeze 114 years later, petroleum and its sister fuel, natural gas, were providing about three-quarters of the nation's energy. U.S. dependence on foreign supplies, so starkly revealed by the 1973 crisis, left many Americans with the impression that the United States was fast running out of oil and natural gas at home. When people learn that about half of our total petroleum resource is still in the ground, the pendulum swing of reaction sometimes leads people to ask, "if the first half was sufficient for a century, why are we worrying?" The answer is twofold:

- Of remaining U.S. supplies, only about 62 billion barrels are proven reserves - reserves that can be extracted from the earth with current technology and prices; the other 50-127 billion barrels include deposits that cannot now be extracted with present know-how and prices.
- The growth in our consumption of petroleum would, in any case, force us to think in decades, not centuries.

In 1859 the U.S. population was about 31 million. Today, it is about 216 million. Furthermore, in 1859 there were few uses for crude oil or its refined products. Today there are more than 100 million gasoline-using automobiles and countless other ways to use petroleum products, including home furnaces, jets, ships, generating stations, boiler fuels, plastics and petrochemicals, fertilizers, asphalt paving and so on.

To truly grasp the dynamics of resource use, one needs to become familiar with the effects of exponential growth. With the development of machines in which to burn the new fuels and with the population growth and rising standards

of living the new fuels helped to support, annual consumption of petroleum and natural gas soon was growing at exponential rates. U.S. crude oil production increased at a rate of 8.3 percent from 1875 to 1929. That means that production doubled roughly every 8.4 years.

In 1929 total U.S. production, which more than supplied domestic wants, was one billion barrels. There was a brief period in the early years of the Great Depression when production declined. It then resumed its growth at an annual rate of 5.6 percent a year until the 1960's, when it began to slow down. Production of domestic crude oil peaked in 1970 at more than three billion barrels and has declined slowly every since.

In 1956, M. King Hubbert, a maverick geologist who worked for the Shell Oil Company and later for the United States Geological Survey (USGS), predicted that the U.S. production would peak between 1966 and 1971. It was Hubbert who also maintained that USGS estimates of petroleum yet to be found and produced were erroneously high. In 1975, the USGS completed a new assessment that sharply cut back on these estimates, bringing them much closer to Hubbert's.

Meanwhile, domestic production declined but American use of petroleum did not. When use outstripped domestic production, the difference was made up by imports. In the early 1960's, imports - which cost less than the home product - were supplying 15 to 20 percent of the U.S. needs and would have supplied a larger fraction had not the U.S. government, beginning in 1959, set quotas holding imported oil at those proportions for years.

Just before the embargo, U.S. petroleum consumption had reached 18 million barrels a day, a rate that works out to about 6.5 billion barrels a year. This pattern of increasing consumption was interrupted sharply by the curtailment of Arab oil and, after the flow resumed, by the new higher price.

OPEC oil went from \$1.80 a barrel before delivery to \$10.50 a barrel, five times the price of two years earlier. Import taxes and delivery brought the price to \$13 a barrel. The reaction was dramatic.

Total consumption of energy actually declined in 1974 and 1975 from the all-time high reached in 1973. Then, in 1976, it began to grow again, but at a slower rate. Since that time, the oil Cartel has increased oil costs at almost regular intervals to the importing nation. Now in 1979, cartel oil is over \$20 per barrel -- and we use about 8.5 million barrels of it per day!

Time Required: 30 minutes

Materials: Dittoed discussion/worksheets

Procedure:

1. Make a spirit master of Worksheet 1.
2. Work through problems discussing them with students.

References:

1. Adapted from Energy Options, League of Women Voters, Copyright, League of Women Voters Education Fund. (Order from League of Women Voters of the U.S., 1730 M Street, N.W., Washington, D.C. 20036; publication #628, \$1.00), 1977, pp. 6-7.
2. Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. pp. 41-42.

Worksheet #1

Petroleum - What's Left?

Most of the world is in a serious energy crisis simply because our demand for energy will soon exceed the world supply of available and useful energy fuels. There are varying estimates as to exactly when our oil and gas will run out. The world is consuming petroleum today at the rate of 20 billion barrels per year (about 6.5 billion of it by the United States). The world's total reserves are not known today since some oil fields are still being discovered, but the recoverable known reserves in the free world are estimated to be about 650 billion barrels.

Of the remaining U.S. supplies, only about 62 billion barrels can be extracted with current technology and at economically feasible costs. U.S. oil production peaked in 1970 at about 3.3 billion barrels per year, and has been declining ever since.

Work the following resource problems:

1. At the current rate of world consumption, calculate the approximate number of years left until our supply of world oil is exhausted. This number is called the static reserve index for world oil.

Note: Since the world oil consumption rate itself increases, we have much less time left before reserves are exhausted.

2. Using the 1970 rate of production of U.S. oil, calculate the approximate number of years left until we exhaust our domestic petroleum reserves.

3. Find the average amount of oil used daily by the United States. (Use a 365-day year.)

1. Assuming that the population of the United States is approximately 216 million, calculate the average number of gallons of oil consumed by each citizen per day. (1 barrel of oil = 42 gallons.)

5. Determine the percent of the world's annual supply of oil being used by the United States.

6. Passenger cars consume nearly 30 percent of all oil used in the United States. Determine the number of barrels of oil consumed by U.S. passenger cars on a

- a. yearly basis
- b. daily basis

#4

Activity Title: "How Much Energy Is In a Barrel of Oil?"

Background: A barrel of crude oil, 42 gallons, has a certain quantity of thermal energy locked in it. This energy is equivalent to the energy we could get by burning about six thousand cubic feet of natural gas or approximately a quarter-ton of coal.

In 1900, Americans were consuming about 4 million barrels of oil equivalent energy (O-E) per day. By 1950, at mid-century, the United States was using 16 million barrels of oil-equivalent energy every day; by the year 1960, that had grown to 21 million barrels daily.

To supply our entire national energy needs in 1973, America used 36 million barrels of oil equivalent energy each day; and, by 1980 some experts think we could be using nearly 60 million barrels of O-E energy per day.

Time Required: 30 minutes

Materials: Dittoed discussion/worksheet

Procedure:

1. Make a spirit master of the following worksheet.
2. Work through problems, discussing their solutions.

Reference: Energy-Critical Choices Ahead, U.S. Dept. Of Commerce, 1975, pp. 2-3.

The Oil Barrel

How much energy is there in a barrel of oil? How much work will it do?

It's enough to heat the average American home to 63° through 4½ days of freezing weather. The energy contained in 10 barrels of oil is enough to move the family sedan from New York to Los Angeles and back. One hundred barrels of oil will take a loaded jetliner from Washington D.C. to Chicago. 1,000 barrels will run the city of Baltimore for 10 minutes. One million barrels of oil will supply all the energy requirements of the State of California for about 8 hours.

A Btu is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. The Btu equivalents of some common fuels are as follows:

1 barrel (42 gallons)	
crude oil	= 5,800,000 Btu's
1 ton coal	= 26,000,000 Btu's
1 kilowatt hour	
electricity	= 3,412 Btu's
1 cubic foot of	
natural gas	= 1,000 Btu's
1 million barrels	
of oil	= 5.8×10^{12} Btu's
1 million barrels per	
day oil equivalent	= 2.117 (Q)
	(Quadrillion
	Btu's per year)
	(1 Q = 10^{15})

Work the following problems:

1. In 1973, the U.S. used 36 million barrels of oil equivalent (O-E) energy per day. How many tons of coal would have had to be burned to supply this much energy?
2. If a home used 1000 kilowatt hours of electricity during one winter month, compute the equivalent amount of O-E energy in barrels of oil.
3. How many Btu's of heat energy would be released every hour by a power plant burning 100 barrels of oil per hour, if only 40% of the original energy content were transformed into electricity?
4. How many cubic feet of natural gas would have to be burned at sea level to provide the amount of energy contained in 100 barrels of oil?
5. Some experts believe by the year 2000 our energy demand could be as high as 95 million barrels of O-E energy per day. Convert this to quadrillion (Q) Btu's per year.

#5

Activity Title: "Skyrocketing Oil Imports"

Background: Because of relatively low prices, air pollution restrictions, and the growing use of automobiles, petroleum demand in the United States has increased at an annual rate of 4.6 percent in the 1960's and early 1970's. Meanwhile, domestic production peaked at 9.6 million barrels per day (MMB/D) in 1970 and has been declining ever since to the current production of 8.2 MMB/D.

The early 1950's also marked the end of our role as an oil exporter. As U.S. demand outstripped domestic production in the post-World War II boom, we turned to foreign sources to fill the ever-widening gap. The figures tell the story. In 1960, imported oil supplied 19 percent of the oil consumed in the United States. At the time of the 1973-74 oil embargo, this figure had reached 37 percent. Despite startling price increases, despite alarms and excursions about energy vulnerability, during the summer of 1979 it stood at about 50 percent.

Time Required: 15 minutes

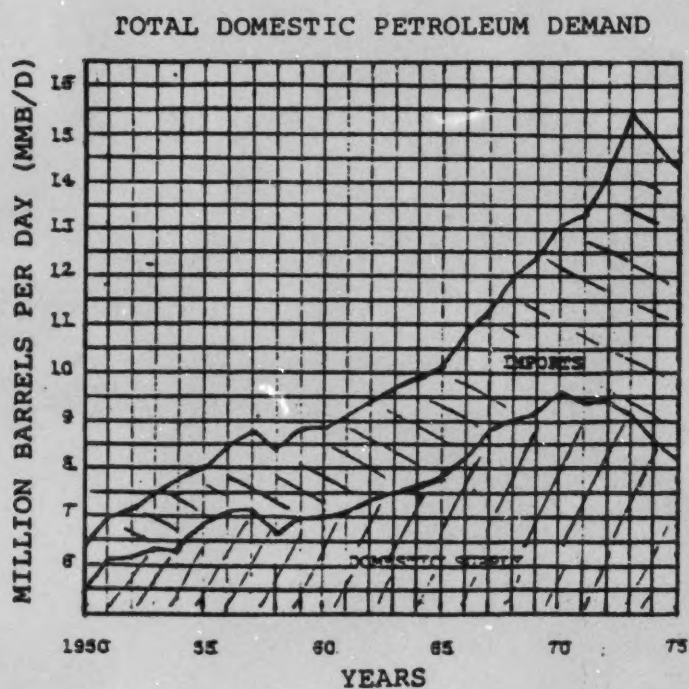
Procedure:

1. Make a transparency of "Total Domestic Petroleum Demand".
2. Project the graph and discuss answers to the following questions:
 - a. Estimate the number of barrels of oil that were used daily by the United States during the following years:
 - a. 1950
 - b. 1975
 - b. Estimate the number of barrels of oil that were imported daily by the United States during the following years:
 - a. 1950
 - b. 1975

c. Compute the percent of daily consumption of oil that was represented by oil imports during the following years:

a. 1950

b. 1975



3. Tabulate 1970, 1975 costs on chalkboard.

The Arab oil embargo in 1973/1974 and the revolution in Iran during 1979 demonstrated that the United States is vulnerable to severe supply disruptions and oil price increases. The cost of a barrel of imported oil has increased from approximately \$2.42 in 1970 to over \$20 in 1979. During that same period of time, domestic oil increased in cost from \$3.18 per barrel in 1970 to over \$9.00 per barrel in 1979.

Discuss answers to the following questions:

- d. Determine the actual increase in cost, from 1970 to 1979, for a barrel of:
 - a. imported oil
 - b. domestic oil
- e. Determine the percent increase in cost, from 1970 to 1979, for a barrel of:
 - a. imported oil
 - b. domestic oil
- f. Assuming a 365-day calendar year, calculate the total cost for imported oil to the United States during the year:
 - a. 1970 (3.5 MMB/D)
 - b. 1979 (6.2 MMB/D)

References: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office 1977. pp. 41-45.

DAY II ACTIVITIES

TRANSPORTATION

Choose approximately 30 minutes of support activities from the following list.

Objective

Students will be able to apply mathematics to the solution of problems related to energy consumption and conservation in the transportation sector.

#1 Activity Title: "Low Tires - Low Mileage"

Background: Under-inflated tires cause a loss in mileage of up to 10 percent. Radial ply tires allow up to 6 percent better gas mileage because they produce less rolling friction.

Time Required: 20 minutes

Materials: Spirit master, Problem #1.

Procedure:

1. Make a spirit master of Problem #1.
2. Work through the solution with students.

Reference: Computations About the Sources and Conservation of Energy.

Florida State Energy Office, 1977, pp. 9-10.

Problem #1

Suppose your compact car averages 27 miles per gallon with properly inflated tires and you travel 15,000 miles each year.

a. Determine the number of gallons of gasoline you would use with properly inflated tires (nearest tenth of a gallon).

b. Assuming your tires were underinflated, causing an 8 percent loss in mileage, compute the number of miles per gallon you would obtain (nearest tenth).

c. Determine the number of gallons of gasoline you would use with improperly inflated tires during the year (nearest tenth).

d. At the rate of 95¢ per gallon, compute the money you would save by having properly inflated tires.

#2

Activity Title: "Pulling Trailers"

Background: Pulling trailers with automobiles can reduce mileage up to 40%.

Time Required: 20 minutes

Materials: Spirit master, "Trailers"

Procedure:

1. Make a spirit master of "Trailers".
2. Work through the problem with students.

Reference: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. pp. 10.

Trailers

Pulling a trailer with an automobile will always result in a decrease in gas mileage because of the added weight and friction. Some trailers are streamlined in design to minimize this loss of efficiency but some are not. A certain streamlined trailer has been found to reduce mileage by 21 percent. Another trailer of about the same size and weight, but not streamlined, has been found to reduce gas mileage by 37 percent. Assume your car averages 16 miles per gallon when not pulling a trailer. Compute, to the nearest tenth, the number of gallons of fuel you would use round-trip from Denver to Grand Junction, a total of 516 miles, when pulling:

- a. The unstreamlined trailer.
- b. The streamlined trailer.

Determine the savings in the cost of gasoline by using a streamlined trailer for the above trip if gasoline costs an average of 95¢ per gallon.

#3

Activity Title: "Power"

Background:

Power is the rate energy is used. For example, kilowatts (kw) are units describing the rate of flow of energy and kilowatt-hours (kwh) are units for the total amount of energy transferred.

Energy can be measured in abstract units, like British Thermal Units (Btu's, one of which heats 1 pound of water 1 degree Fahrenheit), in gallons of gasoline (which are defined to contain a certain number of Btus) or in units of fuel output, such as "heat for x-number of homes," "gasoline enough to drive a Volkswagen three times from Limon to Copper Mountain," and so forth.

Power is usually measured in watts (kilo-, mega-, giga-, referring to 1 thousand, 1 million or 1 billion) or in units of fuel used/time taken, such as barrels of oil/day.

Time Required: 20 minutes

Materials: Spirit master of "Power" worksheet.

Procedure:

1. Explain the difference between power and work:

$$\text{Work} = \text{Force} \times \text{Distance}$$

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Force} \times \text{Distance}}{\text{Time}}$$

2. Distribute dittoed copies of "Power" worksheet.
3. Work through the problems with your students.

Reference: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. p. 13.

Power

Power is a measure of the speed work is done. To accomplish a certain amount of work over a long period of time may require little power. To accomplish the same amount of work in a shorter time requires more power.

You are probably familiar with the word "horsepower" used to describe the power of engines. One horsepower simply means doing work at the rate of 550 foot-pounds every second. Therefore, a 10-horsepower engine can do $550 \times 10 = 5,500$ foot-pounds of work in one second.

1. Convert the following measurements of power to horsepower:
 - a. 4,400 foot-pounds per second
 - b. 110,000 foot-pounds per second
2. Determine the equivalent number of foot-pounds per second of power generated by the following engines:
 - a. $2\frac{1}{2}$ H.P. lawnmower
 - b. 225 H.P. automobile

#4

Activity Title: "Slowing Down"Background:

With automobiles the greatest consumption of fuel occurs at high speeds or very rapid acceleration. Most automobiles get about 28 percent better mileage at 50 miles per hour than at 70 miles per hour.

An automobile traveling at 55 miles per hour gets about 21 percent better mileage than when traveling at 70 miles per hour.

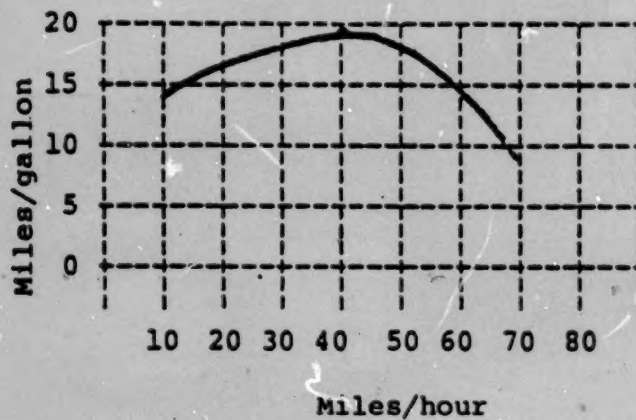
Time Required: 10 minutesMaterials: Overhead projectorProcedure:

1. Make a transparency of Fig. 1.
2. Help students to answer the following questions using the graph.

Reference: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. p. 17.

Fig. 1.

The graph below indicates the miles per gallon the average automobile gets at different speeds.



1. Determine the number of miles per gallon the average automobile gets at the following speeds:
 - a. 10 miles per hour
 - b. 40 miles per hour
 - c. 55 miles per hour
 - d. 70 miles per hour (an illegal speed)
2. What percent greater mileage does one get traveling at 40 mph than 60 mph?

#5

Activity Title: "If Everybody Would, Then..."

Background: An effective energy conservation plan depends upon everyone contributing his share.

Time Required: 10 minutes

Materials: Chalkboard

Procedure:

1. Copy problem #1 onto the chalkboard.
2. Work through its solution with students.

Reference: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. pp. 21-23.

Problem #1

Approximately 40 million automobiles are used to travel to and from work each day in the United States. It has been estimated that an average savings of 3.2 gallons per week for each car has been obtained by reducing the speed limit from 60 mph to 55 mph.

- a. Compute the number of gallons of gasoline estimated to be saved weekly by lowering the speed limit to 55 mph.
- b. At an average price of 95¢ per gallon, determine the savings per week for the 40,000,000 automobiles traveling to and from work.
- c. Determine the annual savings.

MATHEMATICS

DAY III ACTIVITIES

HOME ENERGY

You will need to choose approximately 30 minutes of support activities from the following list.

Objective:

Students will gain practice in applying mathematics to the solution of problems related to energy consumption and conservation in the home environment.

#1

Activity Title: "How Much is a Quad?"Background:

Energy is "how much work" while power is "how fast." For example, kilowatts (kw) measure the flow of energy and kilowatt hours (kwh) measure the total amount of energy transferred.

The energy unit that is gaining popularity is the quad, or Q, which provides a basis for discussing total energy use in the United States, the sufficiency of present supplies and estimates of future consumption. A quad stands for one quadrillion (10^{15}) Btu's. Currently, the U.S. is using 75 Q per year.

Power is usually measured in watts (kilo-, mega-, giga-, referring to 1 thousand, 1 million or 1 billion) or in units of fuel used/time taken, such as barrels of oil/day.

Time Required: 15 minutes

Materials: Chalkboard/overhead projector

Procedure:

1. Define a Quad for students.
2. Ask them to find out how big a Quad is by working this problem:
 "If I gave you a Quad of dollars under the condition that you must spend one million dollars per day, how long would a Quad of dollars last?" (Answer: 2,740 millenia. A millenium is 1000 years.)
3. On the chalkboard or overhead transparency write:

<u>1978 Energy Consumption, Q</u>	<u>Year 2000 projected consumption, Q</u>
78	150

Ask students to solve the following:

- a. Approximately how many years would it take for energy consumption to double (doubling time) assuming the projection to be valid?
- b. Using 150 Q as the estimated United States energy consumption for the year 2000, calculate:
 1. the actual increase, in Quads, of energy consumption for the year 2000, as compared to 1978.
 2. the ratio of the actual increase in energy consumption to our 1978 consumption.
 3. the percent of increase in use of energy projected for the year 2000 over the year 1978.

Reference: Computations About the Sources and Conservation of Energy,
 Florida State Energy Office, 1977. pp. 46.

#2

Activity Title: "Meter Readers"

Background: Reading electric and gas meters is easy, and it is important in monitoring consumption.

Time Required: 10 minutes

Materials: Overhead projector

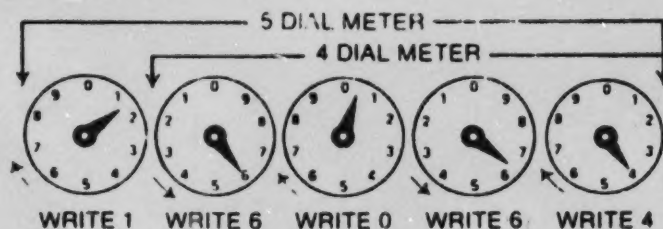
Procedure:

1. Make a transparency of Fig. 1.
2. Work through the illustration with students.
3. If time permits, have students draw a 5-dial meter. Exchanging his paper with a neighbor's, each student can "read" an additional meter.

Reference: Energy, Food and You, Washington State Office of Public Instruction, 1978, p. 176.

HOW TO READ YOUR ELECTRIC METER

The dials are like watch faces lined in a row (every other dial moves counterclockwise). The reading for a five dial meter would be 16,064. The reading for a four dial meter would be 6,064.



Notice that when the pointer is between two numbers, you should record the lower of the two numbers.

When the pointer seems to be directly on a number, look at the dial to the right; if the pointer on the right side dial has passed "0", then write down the number the pointer seems to be on; if the pointer on the right side dial has not passed "0", then write down the previous lower number on the dial you are recording.

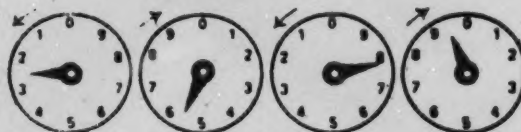
RECORD THE READINGS FOR THE FOLLOWING METERS

METER NO. 1



A

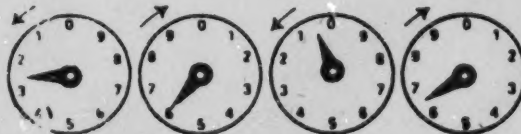
METER NO. 2



A



B



B

Subtract the number on line A from the number on line B to find the number of KWH of electricity used.

METER NO. 1

Line B

Line A

KWH used

METER NO. 2

Line B

Line A

KWH used

#3

Activity Title: "Insulation Saves Money"**Background:**

Any insulating medium retards the flow of heat which always occurs from the space of higher temperature to the space of lower temperature. Since heat is conducted from the inside of our homes to the colder outside during the heating season and from the hotter outside into the home during the cooling season, two practical actions can effectively reduce heat loss (or heat gain) via conduction through ceilings, walls, floors and basements:

1. Reduce the furnace thermostat setting in winter (raise the air conditioner's thermostat setting in summer).
2. Add additional insulation where possible. (Colorado's energy code specifies that the minimum standards for new homes built after October 1, 1977, shall be R-11 (3½ inches of fiber glass or equivalent) in exterior walls and R-19 (6 inches of fiberglass or equivalent) for ceilings/attics.

In addition, insulating floors over unheated spaces and the edges of of concrete slab floors are desirable modifications, but usually not as cost effective as ceilings and walls.

Insulation materials vary in their ability to slow the transmission of heat. This ability is designated by the materials' R-Value (R for Resistance). The higher the R-Value, the greater the resistance to heat flow. Also, increasing the thickness of existing insulation with material of the same type or R-Value increases the resistance to heat flow proportionately.

Thus, considerable energy savings can be realized in a relatively short "investment payback period" by upgrading the insulation in your home to the recommended levels.

Time Required: 30 minutes

Materials: Spirit master

Procedure:

1. Make a Spirit master of Worksheet #1.
2. Work through the problem with students.

Reference: Energy Information Associates, Inc., 2690 W. Main Street,
Littleton, Colorado 80120

WORKSHEET #1

Table 1.

<u>Fiberglass Insulation</u>	<u>Estimated % Fuel Savings</u>
6 inches (15.2 cm), attic floor	28%
3 inches (5 cm), exterior wall	11%
2 inches (5 cm), under lower floor	10%

The Joneses want to cut their winter heating and summer cooling bills for their home in Durango. Last summer they paid \$150.00 and last winter, \$300.00, just to keep their home comfortable.

- a. They decide to insulate their uninsulated home (built in 1952) with fiberglass batts. For the greatest savings they should insulate their _____ first with _____ inches of insulation. This insulation cost them an initial investment of \$504.00. Estimate their maximum dollar savings this summer and winter, based on last year's bills and constant energy prices.

This summer \$ _____

Total savings, this year \$ _____

This winter \$ _____

- b. How many years might it take for them to save enough energy dollars to pay back their investment at constant energy prices?
- c. Suppose they install three inches of insulation in their exterior walls. This could result in an additional savings of _____%. Now they could save up to _____% of their heating fuel this winter, or up to \$ _____.

#4

Activity Title: "Seal Those Cracks!"Background:

Infiltration, or the passage of outside air into a house through cracks, open doors or windows, causes heat loss in winter and unwanted heat gain in summer. Installing weather stripping on doors (especially attic doors) and windows and caulking cracks can reduce about one-third of your heat loss in winter and heat gain in summer.

It is especially important to curb energy waste through the attic since hot air rises. For example, a quarter inch (.6 cm) crack around a small attic access door (3' x 3') allows warm air to escape through thirty-six square inches (232 square centimeters). At current energy prices this leak can cost the consumer over \$20 each year or about 56¢ per square inch. The average homeowner may easily spend twice this amount trying to seal cracks in his home with energy dollars.

Another problem resulting from the passage of warm air through the ceiling, to the attic and through the roof is that of condensation. Hot air can contain more moisture than the same volume of cold air. In the attic where the winter temperature is approximately midway between the outdoor and conditioned space temperatures, water vapor condenses, wetting the structural members and insulation. This causes rotting, mildewing and damage to the insulation causing it, in turn, to lose much of its insulating properties. In a house with only fifteen square inches of air leakage into the attic, over two quarts of water per day can condense into the attic if the relative humidity is maintained near 30%.

Reference: Energy Information Associates, Inc., 2690 W. Main Street,
Littleton, Colorado 80120.

Problem 1

Small air leaks around doors and windows can cost you extra money and waste energy. It has been calculated that in the colder regions of Colorado one square inch (6.45 square centimeters) of air space in exterior walls costs nearly 56¢ extra per year.

Mr. Smith has three exterior doors in his house (each measures 7 feet by 3 feet) and there is a $1/8$ " (.3cm) crack around each one.

- a. Find the perimeter (distance around) of one door in inches. In centimeters (Hint: There are 30 cms per foot).
- b. Find the air leak area of one door (perimeter $\times$ $1/8$ inch (or .3 cm)).
- c. What is the air leak area of the three doors combined?
- d. How much extra money has Mr. Smith paid during the last year for his leaky doors?

#5

Activity Title: "What's Your EER?"

Background:

If you are considering purchasing a new air conditioner or replacing your old one, you should know how to judge their performance.

One way is to size the unit according to its cooling capacity. In Colorado's dryer climate an air conditioner which will remove 12 - 15 Btu's of heat from room air every hour per square foot of floor space is adequate. (Recall that 1 Btu is the amount of heat energy needed to raise the temperature of one pound of water 1⁰F.) Therefore, an air conditioner rated at 15,000 Btu's per hour (its cooling capacity) will remove 15,000 Btu's of heat from a space every hour. If the gross floor area of the conditioned space is 1000 square feet, then 15 Btu's will be removed for each square foot of floor. Installing a unit with a cooling capacity greater than 15,000 Btu's/hour in the same space or "oversizing", as it is called, will result in energy waste and extra operational cost.

Another way to choose is to select a unit with a good "energy efficiency ratio" or EER, usually found on the metal rating plate of the unit. The EER is defined as follows:

$$\text{EER} = \frac{\text{Cooling capacity in Btu's/hour}}{\text{Electric power requirement in watts}}$$

Thus, the EER is an indication of how many Btu's of heat energy can be removed in one hour from room air by one watt of electrical power. For example, a 15,000 Btu/hr unit rated at 1,500 watts yields an EER of 15,000/1,500 or 10 Btu's/hour per watt, an exceptionally efficient unit.

Actually, both the EER and cooling capacity should be used in selecting an efficient model, correctly sized for your home.

Time Required: 20 minutes

Materials: Chalkboard, overhead projector/spirit master

Procedure:

1. Describe and define "cooling capacity" and EER on the chalkboard.
2. Make a transparency or spirit master of Problem 1, working through it with students.

Reference: Energy Information Associates, Inc., 2690 W. Main Street,
Littleton, Colorado 80120

Problem 1

Mrs. Johnson wants to purchase an air conditioning unit for her home in Lamar (2000 square feet), but she doesn't know how large a unit to buy.

- a. Given the general rule of 15 Btu per hour per square foot for Colorado's cooling requirements, calculate the size of unit appropriate for Mrs. Johnson's home.
- b. How many Btu's of heat will this unit remove from Mrs. Johnson's home environment every hour?
- c. Mrs. Johnson finds three air conditioners with a cooling capacity close to that calculated in (a) above:

Brand X:	2400 watts	29,000 Btu/hr	\$1,725.00
Brand Y:	3600 watts	35,000 Btu/hr	\$1,990.00
Brand Z:	4000 watts	25,000 Btu/hr	\$1,750.00

Which brand has the highest EER ($EER = \frac{\text{Btu/hr}}{\text{Watts}}$)?

- d. Which unit is probably the best suited for Mrs. Johnson's home?

MATHEMATICS

DAY IV ACTIVITIES

APPLIANCES

You will need to choose approximately 30 minutes of support activities from the following list.

Objective:

The student will be able to use mathematics in everyday energy consumption applications related to household appliances.

#1

Activity Title: "Computing Appliance Energy Costs"

Background: A basic understanding of simple energy cost calculations can allow the resident to determine which household appliances cost the most to operate. Changes in the habits of usage can then effect savings.

Time Required: 15 minutes

Materials: Chalkboard/Spirit master of Worksheet 1

Procedure:

1. Make a spirit master of Worksheet 1.
2. Copy the following conversion factors onto the chalkboard.
3. Work through the problem with the students.

Conversion Factors

There are:

1000 watts (w) in one kilowatt (kw)

1000 watt-hours (wh) in one kilowatt-hour (kwh)

.754 kilowatts (kw) in one horsepower (HP)

Reference: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. pp. 34-35.

Worksheet 1

Calculating the Costs to Operate Appliances

1. One kwh in Colorado costs 3.62¢ (\$.0362)
Suppose you use 2,000 kwh of electricity per month to cook your food.
At the rate of 3.62¢ per kilowatt-hour, compute the cost of cooking your food.
2. A refrigerator averages 60 watts of power per hour during a 30-day period of time.
 - a. Compute the number of kilowatt-hours of energy used per month if it only cycles "on" 40% of the time.
 - b. Determine the cost of operating the refrigerator during the month.
3. Suppose you use a 200-watt hair dryer for 15 minutes each day for one month (30 days). Calculate the cost of the energy required to operate the dryer.

#2

Activity Title: "What If You Stopped?"

Background: Conserving energy in the home is not just a matter of doing a few things differently. A significant reduction will occur only when you apply many energy-saving methods continuously. In other words, it is a matter of little savings in many different ways that add up to big savings at the end of the year.

Time Required: 15 minutes

Materials: Chalkboard/Overhead projector

Procedure:

1. Make transparencies of Tables 1 & 2.
2. Discuss Table 1 organization briefly.
3. Along with students, compute the annual dollar savings if a home were to discontinue usage of each of the electrical appliances in Table 2.
4. Which appliance costs the most to operate? The least?
5. Which of the items in Table 1 cost the most to operate?
 - a waffle iron or a vaporizer?
 - a warming tray or a water pump?
 - a coffee maker or a deep fat fryer?
 - a heat lamp or a roaster?

Reference: Your Energy Budget Manager, Public Service Co. of Colorado, 1977.

Table 1

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ELECTRIC APPLIANCE OPERATING COSTS

... by the minute, by the hour,
by the day, by the job

NOTE: The darker numbers register cents.
Numbers beyond are fractions of a cent.
For example: .024 equals 2.4 cents. and .0002
represents 2 hundredths of a cent.

ELECTRIC PRODUCT	TYPICAL WATTAGE	COST (INCLUDES FCA)	ELECTRIC PRODUCT	TYPICAL WATTAGE	COST (INCLUDES FCA)
Air Conditioner Room			Hair Dryer		
Bedroom	900	\$.024* hour	Soft Bonnet	400	\$.0144 hour
Family or Living Room	1500	.040 hour	Hard Bonnet	900	.0326 hour
Multiple Rooms	3000	.082 hour	Hand Held	600	.0217 hour
Baby Food Warmer	165	.001 10 minutes	Hair Rollers	350	.0032 15 minutes
Blanket	175	.025* night	Heat Lamp	250	.0091 hour
Blender	385	.0002 minute	Heating Pad	65	.00126* hour
Broiler (Portable)	1500	.027 30 minutes	Hi-Fi/Stereo	100	.0036 hour
Can Opener	100	.00006 minute	Hot Plate	1250	.0227 30 minutes
Carving Knife	92	.0003-5 minutes	Humidifier	175	.0189 day
Clock	2	.052 month	Ice Cream Freezer	130	.0036 45 minutes
Coffee Maker	850	.0052 10 minutes	Ice Crusher	100	.00031 5 minutes
Cooker (Egg)	516	.0016 5 minutes	Iron (Hand)	1000	.0199* hour
Curling Iron	40	.0003 15 minutes	Iron (Mangle)	1525	.0304* hour
Corn Popper	575	.0052 15 minutes	Juicer	90	.00005 minute
Deep Fat Fryer	1500	.033* hour	Knife Sharpner	100	.00031 5 minutes
Dishwasher	1200	.0253 normal cycle	Lights -- 100 watt bulb	100	.036 10 hours
Disposer	420	.0003 minute	Make-up Mirror	20	.00018 15 minutes
Dryer	5000		Microwave Oven	1500	.0136 15 minutes
Regular Fabrics		.1433 load	Mixer		
Permanent Press		.1095 load	Hand	80	.00144 30 minutes
Electrostatic Cleaner	50	1.30 month (continuous operation)	Standing	150	.0027 30 minutes
Fans			Power Tools		
Attic	375	.0136 hour	Drill (1/4 inch)	240	.00073 5 minutes
Circulating	88	.0032 hour	Saw	660	.00199 5 minutes
Exhaust -- small	200	.0073 hour	Radio	75	.0027 hour
Furnace	660	.0242 hour	Range		
Rollabout	171	.0062 hour	Small Surface Unit	1300	.0039 5 minutes (High Heat)
Window	200	.0073 hour	Large Surface Unit	2400	.0073 5 minutes (High Heat)
Floor Waxer/Cleaner	350	.0126 hour	Oven (non-self-cleaning)	3200	.038* hour
Fondue/Chafing Dish	800	.0147* hour	(self-cleaning)	3200	.029* hour
Freezer (15 cu. ft.)	341	3.59* month	Broiler Unit	3600	.0326 15 minutes
Frostless (15 cu. ft.)	440	5.33* month	Self-Cleaning Feature	4000	.126 to .21 2 hours
Fry Pan	1150	.0253* hour	Refrigerator/Freezer (14 cu. ft.)	330	3.44 month
Garden Tools			Frostless (17 cu. ft.)	350	5.16 month
Edger	190*	.0035 30 minutes	Roaster	1350	.029 hour
Hedge Trimmer	265	.0049 30 minutes	Sewing Machine	75	.00274 hour
Garage Door Opener	350	.0002 minute	Shaver	14	.00004 5 minutes
Grinder (Food or Coffee)	150	.0009 10 minutes	Shaving Cream Dispenser (Heated)	60	.00003 minute
Griddle	1200	.016* 30 minutes	Slow Cooker -- Low	75	.0027 hour
Hair Clipper	10	.00006 10 minutes	-- High	150	.0054 hour
			Space Heater	1300	.047 hour

ELECTRIC APPLIANCE OPERATING COSTS

... by the minute, by the hour,
by the day, by the job

ELECTRIC PRODUCT	TYPICAL WATTAGE	COST (INCLUDES FCA)
Sump Pump	85	\$.003 hour
Sun Lamp	250	.0015 10 minutes
Television		
Black & White	160	.0058 hour
Solid State	55	.002 hour
Color	300	.011 hour
Solid State	200	.0073 hour
Toaster	1200	.00144 2 minutes
Toothbrush	7	.000004 minute
Trash Compactor	400	.0012 5 minutes
Vacuum Cleaner	650	.0235 hour
Vaporizer	480	.0174 hour
Waffle Iron	1200	.017* 30 minutes
Warming Tray	140	.0051 hour
Washing Machine (Automatic)	500	.0093 normal load
Water Heater (Quick Recovery)	4500	.08 to .21 per per- son/day
Water Pump	1080	.0391 hour
Yard or Post Lights		
Mercury (Bulb & Ballast)	120	.0477 night
Incandescent (Both based on photoceit control — normal operating hours for one year — 4,000)	100	.0397 night

Many factors affect
lighting costs; size of
the home, type of
lighting, etc. But keep
in mind — fluorescent
lights are more efficient
and more economical
to operate.

GAS APPLIANCE OPERATING COST

APPLIANCE	TYPICAL CONSUMPTION (PER HOUR)	COST (INCLUDES GCA)
Gas Clothes Dryer	20,000 Btu	
Regular fabric		\$.0465* load
Permanent press fabric		.0349* load
Gas Grill	27,000 Btu	.045 hour
Gas Light (two mantle)	2,200 Btu	.087 day
Gas Range — Surface unit	9,000 Btu	.015 hour
Oven	17,500 Btu	.029 hour
Broiler unit	14,000 Btu	.023 hour
Gas Water Heater (40 gallons)	34,000 Btu	.012 to .032*** per per- son/day
Gas Furnace (100,000 Btu rated)	100 cubic feet	.14** hour

*includes cost of electrically operated motor.

**assumes continuous operation for one hour.

***does not include pilot light consumption.

*Thermostatically controlled. Cost based on appliance
estimated "On" time.

Table 2.

Appliance	Estimated Annual Usage (hrs)	Annual * Cost Savings, \$
Toaster	12	
Refrigerator/freezer (Frostless, 17 cu. ft.)	3500	
Radio	600	
Television (Color, Solid State)	1500	
Dishwasher (Normal cycle)	400	
Radar range (Microwave oven)	60	
Total		\$

*Note: One kwh in Colorado costs approximately \$.0362

#3

Activity Title: "Motors Use It"

Background: The average home contains many appliances which are operated by motors. Knowing how to convert from horsepower to kilowatt-hours is important in determining energy costs.

Time Required: 10 minutes

Materials: Chalkboard

Procedure:

1. Copy the following equation and conversion factors onto the board:

Energy = Power x Time

Power: 1 Horsepower (HP) = 746 watts = .746 kilowatts (kwh)

Energy: 1 kwh in Colorado costs \$.0362

2. Copy the following problems onto the chalkboard:

How many kilowatt-hours (kwh) of energy would be used by a 3 HP motor operating at full power for 10 hours?

What would this amount of operation cost in Colorado?

Reference: Public Service Co. of Colorado

#4

Activity Title: "Turn 'Em Off"

Background: Incandescent bulbs use more energy per unit of illumination than fluorescent bulbs. Calculating their operating costs is easy.

Time Required: 15 minutes

Materials: Chalkboard

Procedure:

1. Copy the following data on the chalkboard:

1000 watts (w) = 1 kilowatt (kw)

power (Kw) x time (hrs) = energy (kwh's)

1 kwh costs \$.0362 in Colorado

2. Read the following story problem to students:

"The Smiths left town for the summer. Unknown to them, they had left on the following lamps:

3 - 100 watt lamps

4 - 75 watt lamps

During the 3 month period (2,160 hours), how much money did their forgetfulness cost them?"

How much would it have cost had the seven lamps been 45 watt fluorescents?

Reference: Public Service Co. of Colorado

#5 Activity Title: "Doing Without"

Background: Americans take electricity for granted. Many of the electrical gadgets we use perform tasks for which alternative modes are available. Some alternatives admittedly may be inconvenient in our modern labor-saving age. Which can we eliminate without undue hardship?

Time Required: 15 minutes

Materials: Chalkboard

Procedure:

1. Ask students to raise their hands if they feel they could do without any of the following appliances in their home. Keep track on the board.

2. Ask students who "vote" to eliminate a given appliance to explain how they would accomplish the associated tasks without the appliance.

Which of the following appliances could you do without in your home?

1. electric range
2. dishwasher
3. clothes dryer
4. clothes washer
5. electric can opener
6. refrigerator
7. lamps
8. toaster
9. television set
10. air conditioner

Reference: Adapted from Energy Conservation Activity Packet, Iowa Dept. of Public Instruction and Energy Policy Council, 1977. p. 57.

5

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MATHEMATICS

DAY V ACTIVITIES

FUTURE ENERGY

You will need to choose one culminating activity from the following list.

Objective:

The student will be able to use mathematics to assess the contributions of various alternative sources to future energy supply.

#1

Activity Title: "Solar Systems"

Background: One way to reduce the amount of energy consumed to heat water is to use solar energy.

At noontime the amount of solar energy falling on a surface at right angles to the sun's rays is about:

429 Btu per square foot per hour or

1,200 calories per square meter per hour.

Therefore, if you had a 100 square-foot solar heating panel, the amount of radiant energy impinging on the panel in one hour would be:

$$100 \text{ sq. ft.} \times 429 \text{ Btu/ft}^2/\text{hour} = 42,900 \frac{\text{Btu}}{\text{hour}}$$

Since the panel could not be 100% efficient you would not get this much

heat out of it. So, if we assume 40% efficiency, the amount of heat the panel could produce per hour would be:

$$42,900 \times 0.40 = 17,160 \frac{\text{Btu}}{\text{hr}}$$

(4,324 (calories/hour)

This is sufficient energy in one hour to heat enough water to take one bath, one shower, and to bring water to boil in a large cooking pot.

Time Required: 15 minutes

Materials: Chalkboard

Procedure:

1. Outline the background material on the chalkboard.
2. Copy the following problems on the chalkboard, working through them with the students:
 - a. Public Service Company of Colorado estimates that the average home requires 400 kilowatt-hours of electricity per month for heating water. Using a cost of 3.62¢ per kilowatt-hour, compute the average cost per household to heat water during the period of:
 - i. 1 month
 - ii. 1 year
 - iii. 10 years
 - b. Some solar water heating systems, designed to provide hot water for the average household, cost about \$900 to install. Assuming the solar system will reduce the cost of electricity for heating water by 70 percent, determine the money saved during the period of:
 - i. 1 month
 - ii. 1 year
 - iii. 10 years
 - c. Compute the length of time it would take for the solar water

heating system to pay for itself.

Reference: Computations About the Sources and Conservation of Energy,

Florida State Energy Office, 1977. p. 49.

#2

Activity Title: "Is Coal the Answer?"

Background: Coal is our most abundant domestic fossil fuel. Some estimates of our total domestic coal reserves go as high as three trillion tons. Not all of this supply is recoverable. The more meaningful estimates deal with recoverable reserves. The amount of economically recoverable reserves are estimated at 300 billion tons. At projected production rates however, such amounts would last less than 100 years. *

Estimated current annual production capacity of the coal industry is about 700 million tons. By 1985, this capacity is expected to increase by an additional 535 million tons.

Time Required: 15 minutes

Materials: Chalkboard

Procedure:

1. Read the background information to the class.
2. Write the current annual production rate and the expected 1985 production increase on the chalkboard.
3. Work the following problem with the students.
 - a. Determine the amount of coal estimated to be produced during 1985.
 - b. Write the ratio of the additional number of tons of coal estimated to be produced by 1985 to that which is produced at the present.
 - c. Compute the factor of increase in coal production anticipated for the year 1985.

There is no guarantee that actual production in 1985 will be able to match the anticipated productive capacity.

* Bartlett, Albert A. "The Forgotten Fundamentals of the Energy Crisis", The Journal of Energy Education, Vol. 1, No. 1, 1978. p. 12.

Reference: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. p. 49.

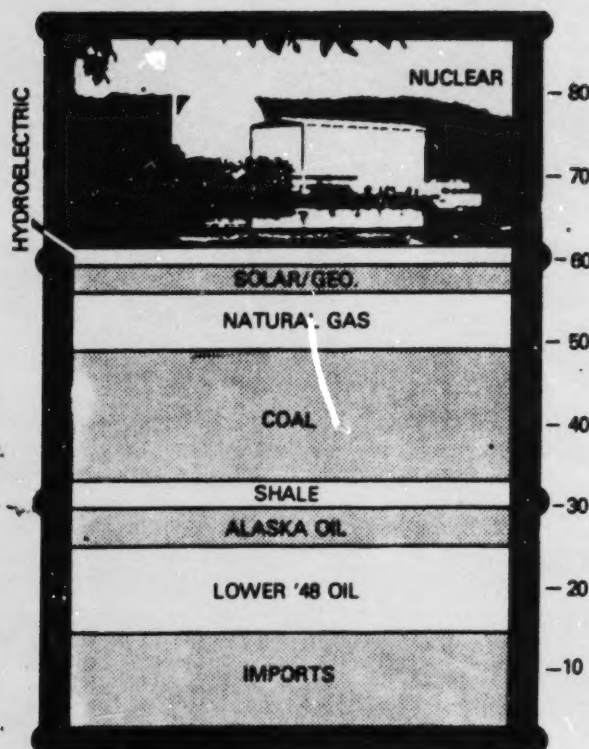
#3

Activity Title: "Topping the Year 2000 Energy Barrel"

Background: According to one scenario, included in the U.S. Department of Commerce publication, "Energy: Critical Choices Ahead", if the historical energy consumption pattern proves true, our energy demand in the year 2000 will be 95 million barrels of oil-equivalent energy per day. Assuming a national commitment to conservation, we can reduce our demand by 11 million barrels per day, leaving an 84-million barrels of oil equivalent energy demand for 2000.

Fig. 1 indicates the projected contributions of alternative sources needed to "fill the barrel."

Fig. 1. The Year 2000 Energy Barrel



Although the tasks involved in filling the barrel to the 60-unit mark are of massive proportion in scope and cost, the only source available to "top the barrel" (24 units) is nuclear energy - the equivalent of one million megawatts (10^9 kilowatts) of power generating capacity.

Time Required: 15 minutes

Materials: Chalkboard/Overhead projector

Procedure:

1. Read the background information above to the class.
2. Display Fig. 1 as an overhead transparency.
3. Discuss the enormous contribution of nuclear, according to this scenario.
4. Work the following problems on the chalkboard with the class.
 - a. To supply 10^6 megawatts of electric power with typical 1,000-megawatt nuclear power plants by the year 2000 is an enormous task. How many would have to be built in the next 22 years (1978-2000) to satisfy the projected demand?

$$10^6 \text{ megawatts} \times \frac{1 \text{ plant}}{10^3 \text{ megawatts}} = 1,000 \text{ plants in 22 years}$$
 - b. On the average how many 10^6 -megawatt plants would have to be built per year? Per month?
 - c. At a 1978 cost of \$1 billion per plant, estimate the cost of building the nuclear power plants computed in (a).
 - d. If our Gross National Product (GNP) were to reach \$1.5 trillion by 2000, what percentage of our GNP would be "invested" in nuclear power plant construction?
 - e. In your opinion, will conservation need to play a much larger role than anticipated?

Reference: Adapted from "Energy - Critical Choices Ahead", U.S. Dept. of Commerce, 1976. pp. 10-12.

DAY I ACTIVITIES

INTRODUCTION

Choose two or three activities from the following list, using them to introduce students to U.S. energy problems.

Objective:

The student will be able to understand the root causes of the U.S. energy dilemma.

#1

Activity Title:

"They Don't Grow on Trees!"

Background:

The fossil fuels - coal, petroleum and natural gas - are indeed fossils, hence the name. Like all other forms of energy, they originated in solar activity. They are the remains of plant and some animal life that thrived in a time of extraordinary photosynthetic activity eons ago and were buried or inundated before they had a chance to decompose in the presence of oxygen.

Under pressure and heat, and lacking oxygen, their decomposition was incomplete. Certain of the organic products - mainly hydrocarbon molecules in which are stored the original energy of the sun - were retained in various grades of richness. Thus, coal is found in several forms, from lignite to sub-bituminous to bituminous to anthracite. In each successive stage, more carbon has been concentrated, therefore more high-quality energy is available

per pound.

Petroleum or its relatives, bitumen and kerogen (hydrocarbon content of tar sands and oil shale, respectively), can be found in various media. The richest deposits of petroleum usually are found in saturated sandstones, where the liquid crude oil flows freely to wells. Other forms are more difficult to exploit. For example, the kerogen found in the U.S. oil shale reserves in three western states can't be exploited by drilling oil wells because it is a solid and does not flow.

The discovery of fossil fuels and the invention of machines in which to burn them formed the basis for the most dynamic of ages so far - the Industrial Age.

It began with the discovery of coal. At first, coal was used like wood; that is, it was burned directly to produce heat. But it led to the inventive uses of the steam engine, the basis of the Industrial Revolution. The American Civil War can be interpreted as a conflict between the coal-fired industrial North and the slave-powered agrarian South.

Later came the discovery of petroleum and natural gas and the developing technology for using these fuels, including the internal combustion engine, the diesel engine and oil- or gas-burning home furnaces. The impacts on society were countless and colossal. For example, the internal combustion engine and abundant gasoline led to our present reliance on the automobile for our transportation system. The automobile, in turn, helped to reshape our major cities, for better or worse, into decentralized, sprawling areas of mixed urban and rural land uses. In so doing, cities evolved from configurations of high energy efficiencies to ones of low energy efficiencies.

With the exploitation of the fossil fuels, however, two extraordinary

conditions were evident. One was that, for the first time ever, people were able to invest more energy into their systems than they reaped from them. The drastic, even extravagant, changes in the U.S. food production system that were spurred by abundant and cheap energy are a prime example. Some scientists have calculated that this system, by becoming increasingly dependent upon ever larger amounts of petroleum-based fertilizers, pesticides, machines, sophisticated transport systems and elaborate packaging - but upon less and less human labor - is now being subsidized by fossil energy at a 1.2-to-1 ratio. That is, it takes 1.2 calories of fossil-supplied energy to produce 1 calorie of food.

There is nothing wrong with this process except that it cannot be sustained indefinitely, because - and this is the second condition - fossil fuels are nonrenewable resources. Unlike renewable resources such as trees or wheat, they are available for use one time only. And unlike other nonrenewable resources, such as metals, they cannot even be recycled, for reasons inherent in the laws of thermodynamics. Once burned, these concentrated storehouses of high-quality energy are gone forever.

Unlike earlier cultures of mankind - those which depended upon and were both created and limited by renewable energy resources - the fossil fuel age is destined to be a brief one. While estimates differ, most indicate that petroleum and natural gas are destined for practical depletion soon, with global shortages expected to occur later this century. This projection is especially threatening to industrial nations, such as the United States, which presently depend heavily upon petroleum and natural gas.

Coal is much more abundant. Quantitatively, it could probably meet energy needs for another century, though only if ways were found to extract and use it without incurring unacceptable environmental costs or insurmount-

able problems in substituting it for the other fuels. Still, even the 500-1,000 years that is generally agreed to be the outside limit for fossil fuel consumption is a short period in human history, miniscule in a geological perspective.

Time Required: 20 minutes

Materials: Overhead projector, chalkboard

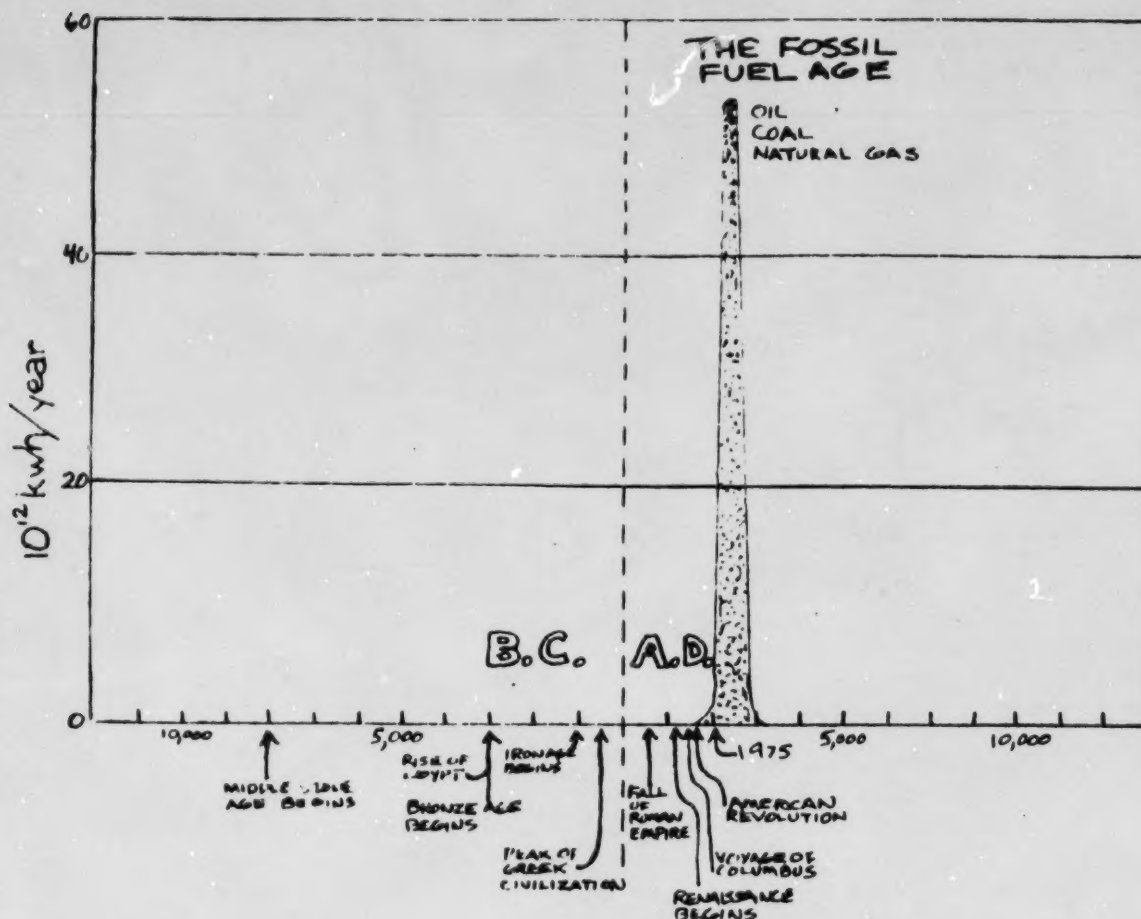
Procedure:

1. Make a transparency of Fig. 1.
2. Discuss graph and quotation.
3. Discuss reasons for the astronomical consumption of fossil fuels during this century.
4. List on the chalkboard other uses for our stock of fossil fuels.

References: Energy Options, League of Women Voters, Copyright, League of Women Voters Educational Fund. (Order from League of Women Voters of the U.S., 1730 M Street, N.W., Washington, D.C. 20036, publication 628, \$1.00), 1977. pp. 2-3.

Energy, Food and You, Washington State Office of Public Instruction, First Draft, 1977. p. 14.

Fig. 1.



"Geochemical evidence suggests that every year about 28 million tons of carbon go into the formation of new fossil sediments. Current consumption of fossil fuels is about 6 billion tons of carbon per year. The rate of consumption is therefore over 200 times the rate of deposition. On this basis we can say that fossil fuels are limited and nonrenewable."

- I. T. Rosenqvist
1972 Conference on
Energy and Humanity

#2

Activity Title: "Where Will It Stop?"

Background: From 1950 until oil prices quadrupled during 1973-74, U.S. consumption of energy increased at the rate of 3.5% per year. This is exponential growth with a corresponding doubling time of about 20 years.

Increasing energy consumption is related to two factors:

1. Increasing population (Note the effect of the post-World War II "baby boom" in Fig. 1.)
2. Increasing per-capita consumption.

Exponential increase in energy consumption cannot continue indefinitely on a non-renewable resource base. There are physical, economic and environmental limits to exponential growth. Where will it stop?

Time Required: 15 minutes

Materials: Overhead projector

Procedure:

1. Make a transparency of Fig. 1.
2. Ask students to respond to questions a - f.

Reference: "Sources of Energy", Activity Guide: Energy & Man's Environment, 1976, p. 22.

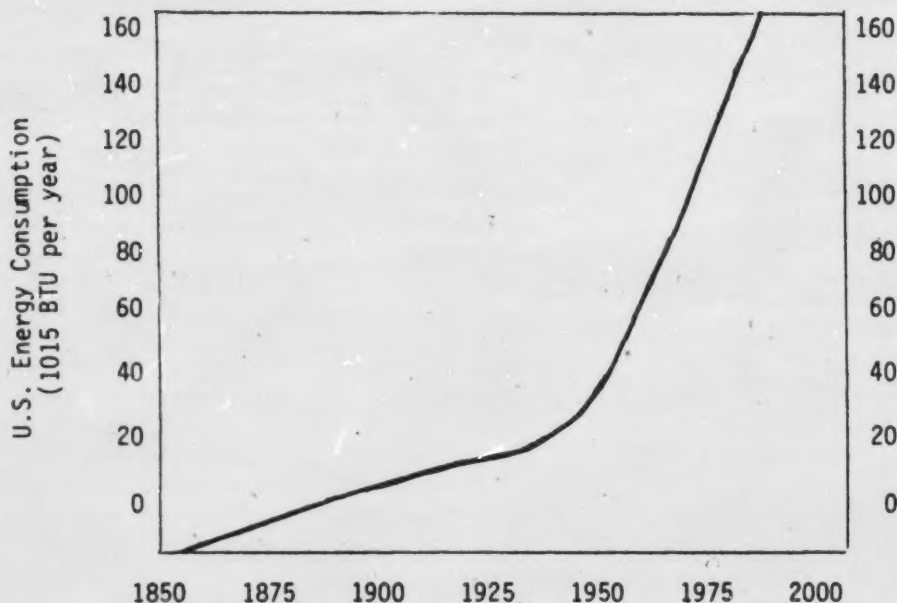


Figure 1 - U.S. Energy Consumption
(From U.S. Bureau of Mines)

Using the graph, respond to the following:

- Select the year 1925 and compare the U.S. energy consumption that year with 1900 and 1950.
- Compare 1975 to 1950.
- How would you use the chart to find the energy consumption in 1960, 1970, and this year?
- About which year did a marked increase in energy consumption begin? How would you account for the increase then?
- Check the U.S. population for the year that you chose in d. above. How does this help explain the increased consumption?
- What will happen if we use energy at the predicted level beyond 1975? What would happen if all other people in the world were to achieve the same level of energy consumption?

#3

Activity Title: "We've Come A Long Way, Baby!"

Background: The nation faces a serious and continuing energy problem characterized by limited energy choices and increasing dependence on diminishing oil and gas reserves. The development of this problem can be traced in the historical evolution of technological man and the energy sources he has used for increasing mechanized activities. (See Fig. 1)

Our most recent energy problem has come about because most of the fuel currently used by the nation is petroleum and natural gas, and these fuel resources are being depleted rapidly. Actions must be initiated to prepare for a transition from oil and gas to a reliance upon renewable energy sources. While, simultaneously, reducing our country's energy demand. Historically, however, such transitions, as illustrated in Figure 2, have required more than half a century.

Time Required: 25 minutes

Materials: Overhead projector

Procedure:

1. Make a transparency of Figs. 1 & 2.
2. Discuss answers to the following questions with students.
 - a. According to Fig. 1, which "man" uses the most energy? About how many times more than "primitive man"? Than "industrial man"?
 - b. Compare "technological man" and "industrial man". Which energy end-use has increased by the greatest factor? The least?
 - c. According to Fig. 2, what energy fuel transitions have been made in the past?"
 - d. Why is a transition to another fuel base needed now?

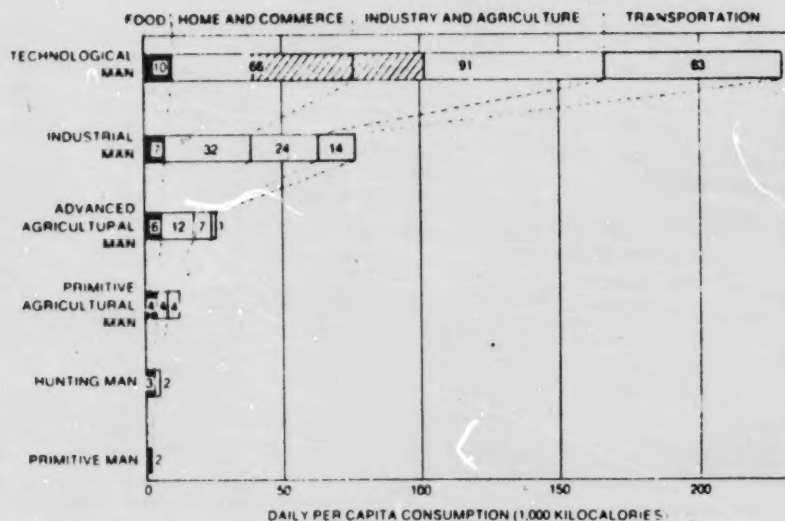


Fig. 1. Evolution of Technological Man

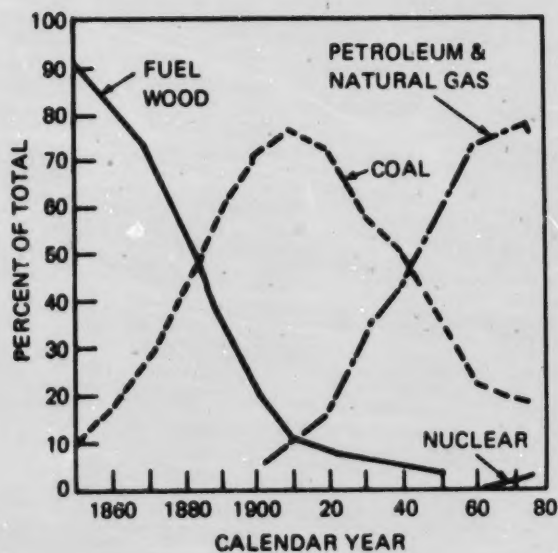


Fig. 2. Energy Transitions

References:

Fig. 1 Used with permission from: "The Flow of Energy in an Industrial Society," by Earl Cook in Scientific American, Copyright Sept. 1971 by Scientific American, Inc. All rights reserved.

Fig. 2 Adapted from: Historical Statistics of the United States Bureau of the Census, U.S. Bureau of Mines, 1974.

#4

Activity Title: "How Long Will They Last?"

Background:

The fossil fuels are not the only "endangered" non-renewable resources - metals and minerals have a finite lifetime as well.

Two indices are used to calculate depletion times of reserves: the static reserve index and the exponential reserve.

The static reserve index (SRI) is defined as:

$$\text{SRI} = \frac{\text{Known amount of reserves}}{\text{Average production rate for a given year}}$$

and assumes a constant rate of use; i.e., static production.

Since rates of production of energy fuels, metals and minerals have been increasing, the SRI gives an overly optimistic picture of a resource's lifetime.

The exponential reserve index (ERI) is defined as:

$$\text{ERI} = \frac{1}{k} \ln \left(\frac{kR}{r_0} + 1 \right)$$

where k is the fractional growth in consumption per year, ln is the natural logarithm to the base e, R is the amount of estimated reserves and r_0 is the current annual rate of production.

The ERI gives a more accurate picture of resources' lifetimes than the SRI; however, since it assumes exponentially increasing production to the "bitter end" of a reserve, it gives a slightly pessimistic depletion time.

Time Required: 20 minutes

Materials: Overhead projector

Procedure:

1. Make a transparency of Fig. 1.
2. Briefly discuss the difference between the SRI and the ERI.
3. Interpret the chart to discuss the following questions:

- a. Which fossil fuel (coal, oil, natural gas) has the greatest global SRI? The lowest? The greatest global ERI? The lowest?
- b. Look at the "petroleum row". Explain why we are dependent on foreign oil.
- c. Which metals have an ERI of less than 30 years?
- d. Why is it important to conserve all non-renewable resources?

References: Energy for Survival, Wilson Clark, 1974, p. 84. (Nonrenewable Natural Resources chart used with permission from Doubleday & Company, Garden City, N.Y.)

NONRENEWABLE NATURAL RESOURCES

Resource	Known Global Reserves	*Static Index (years)	**Exponential Index (years)	Countries or Areas with Highest Reserves (% of world total)	Prime Producers (% of world total)	Prime Consumers (% of world total)
Aluminum	1.17x10 ⁹ tons	100	31	33% Australia 20% Guinea 10% Jamaica	19% Jamaica 12% Surinam	42% U.S. 12% U.S.S.R.
Coal	5x10 ¹² tons	2300	111	32% U.S. 53% U.S.S.R.-China	20% U.S.S.R. 13% U.S.	
Copper	308x10 ⁶ tons	36	21	28% U.S. 19% Chile	20% U.S. 15% U.S.S.R. 13% Zambia	33% U.S. 13% U.S.S.R. 11% Japan
Gold	355x10 ⁶ troy oz.	11	9	40% Rep. of S. Africa	77% Rep. of S. Africa 6% Canada	
Iron	1x10 ¹¹ tons	240	93	33% U.S.S.R. 18% S. Am. 14% Canada	25% U.S.S.R. 14% U.S.	28% U.S. 24% U.S.S.R. 7% W. Germany
Lead	91x10 ⁶ tons	26	21	39% U.S.	13% U.S.S.R. 13% Australia 11% Canada	25% U.S. 13% U.S.S.R. 11% W. Germany
Natural Gas	1.14x10 ¹⁵ cu ft	38	22	25% U.S. 13% U.S.S.R.	58% U.S. 18% U.S.S.R.	
Petroleum	455x10 ⁹ bbls	31	20	17% Saudi Arabia 15% Kuwait	23% U.S. 16% U.S.S.R.	33% U.S. 12% U.S.S.R. 6% Japan
Silver	5.5x10 ⁹ troy oz.	16	13	36% Communist Countries 24% U.S.	20% Canada 17% Mexico 16% Peru	26% U.S. 11% W. Germany
Tin	4.3x10 ⁶ lg. tons	17	15	33% Thailand 14% Malaysia	41% Malaysia 16% Bolivia 13% Thailand	24% U.S. 14% Japan

Adapted from Energy for Survival, Wilson Clark, page 84. Published in 1974.

* Static index year = the number of years known global reserves will last at current global levels of consumption.

** Exponential index = the number of years known global reserves will last with exponential growth of global level of consumption.

#5

Activity Title: "Where Has All the Oil Gone?"

Background:

Though it's clear that the energy "crunch" is coming, forecasters disagree about when the day of reckoning will arrive. The answer obviously depends on how much petroleum still remains, but estimates are riddled with "ifs", "ands" and "buts".

More optimistic forecasts project new discoveries, but the fact is that the rate of new discoveries worldwide has not kept pace with rising consumption. In any case, the experts do agree that U.S. production of oil and gas has peaked and started a downward trend.

Another rare point of agreement in the supply debate: if it weren't for Saudi Arabia, the only oil exporter deemed able to increase production, it could be said that world production of oil has peaked.

What's more, estimates of future world demand are just as nebulous as those gauging supply.

President Carter has taken a relatively pessimistic view of the energy future. He projects that worldwide demand for oil will overtake production in the late 1980s or early 1990s, causing steep price hikes by the OPEC oil exporters. These, in turn, will trigger massive economic dislocations and bitter competition for dwindling oil resources that will threaten world stability . . . unless, that is, the United States takes steps now to shift gears.

Evidence of the coming petroleum crunch:

1. The results of exploration and the effects of demand and production can be measured by our proved reserves - oil that is economically recoverable with existing production technology. Our proved reserves grew

steadily until 1955. Then for several years, discoveries just about balanced production. In the late 1960's, reserves began falling. The addition of Alaskan discoveries in 1970 gave our reserves a temporary shot in the arm, but the trend is still downward. (See Fig. 1.)

2. It is even more revealing to show how proved reserves have declined relative to consumption. In 1940, the R/C* ratio was equivalent to 17 years. That ratio has declined steadily, to less than seven years' supply in 1975. Figure 2 shows the effect of the Alaskan North Slope oil discovery.

On a worldwide basis, United States proved reserves of crude oil have fallen from about one-third of the world's total in 1950 to only five percent last year.

This look at the past shows some disturbing trends in our energy supply and demand. The natural - and most important- question is: What does the future hold? (See Fig. 2.)

* Note: $R/C \text{ rate} = \frac{\text{bbls}}{\text{bbls/year}} = \text{years}.$

Time Required: 15 minutes

Procedure:

1. Make a transparency of Fig. 1 and 2.
2. Ask students to interpret Fig. 1 and answer the following questions.
 - a. What is the overall trend visible for our crude oil reserves?
 - b. What, do you think, does the 1970 hump on the curve represent?
3. Explain the meaning of the "R/C ratio".
4. Ask students to interpret Fig. 2 and answer the following questions:
 - a. What is the overall trend in the R/C ratio?
 - b. When did the R/C ratio fall below 10?
 - c. The 1970 discovery of Alaskan oil boosted the R/C ratio from 6 years to about _____ years.

Fig. 1

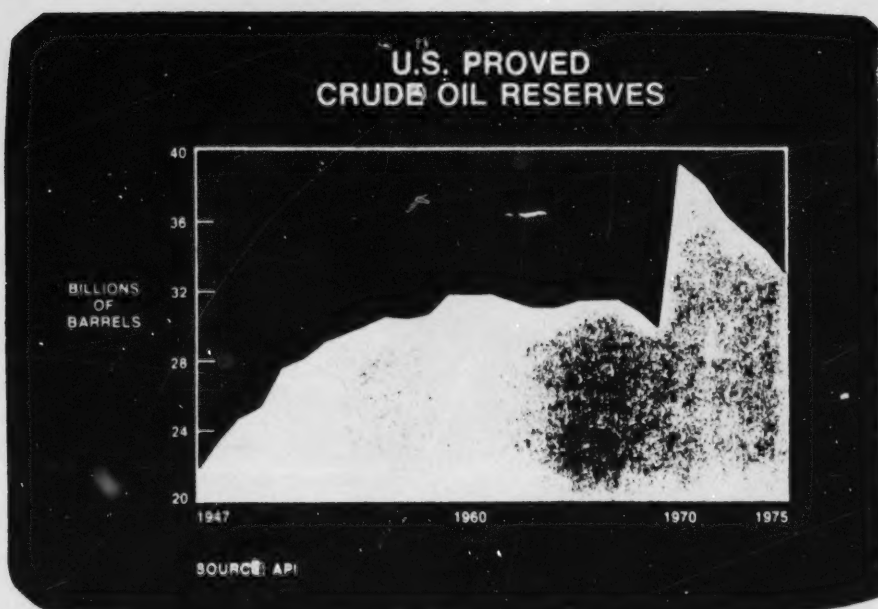
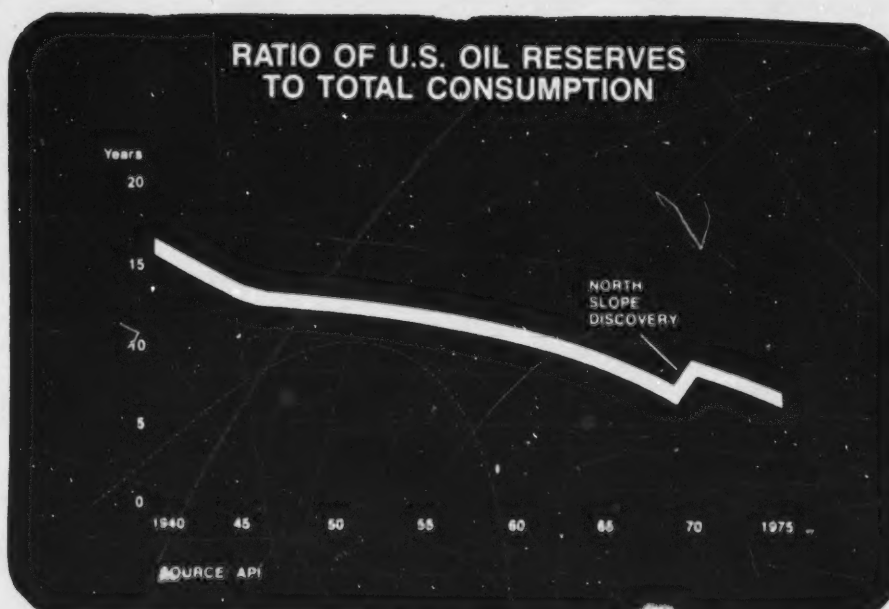


Fig. 2



d. As of 1975, and assuming no discoveries of major proportions, how many years are left before we deplete our domestic reserves of oil?

Reference: U.S. Energy: Yesterday, Today & Tomorrow, American Petroleum Institute, 1977, pp. 10-11.

DAY II ACTIVITIES

TRANSPORTATION

You will need to choose approximately 30 minutes of support activities from the following list.

Objective:

Students will be able to understand the relationships among energy, work, power and the transportation sector's contribution to our energy problems.

#1

Activity Title:

"In A Hurry to Run Out of Gas"

Background: Fuel consumption increases rapidly at high speeds. Not only does energy depend on the speed of an object but kinetic energy increases with the square of the speed. This means that if a car doubles its speed, its energy will be four times greater. If the car triples its speed its energy will be nine times greater.

This explains why man's desire to do things quickly is one reason why we have an energy crisis.

Time Required: 20 minutes

Materials: Spirit master of Worksheet #1

Procedure:

1. Make a spirit master of Worksheet #1.

2. Explain to students that the kinetic energy of a moving object is $KE = 1/2 mv^2$ and that KE depends on v^2 , where m is mass and v is velocity.
3. Work through the problem with students.

Reference: Adapted from Computations About the Sources and Conservation of Energy. Florida State Energy Office, 1977. p. 20.

Worksheet #1

1. Suppose a 1000-kilogram car is traveling at a speed of 5 meters/sec (30 mph). Compute its kinetic energy in joules:

$$KE = 1/2 mv^2 = 1/2 (1000 \text{ kg}) \times (5 \frac{\text{m}}{\text{sec}})^2 =$$

$$\underline{\hspace{2cm}} \frac{\text{kg} \cdot \text{m}}{\text{sec}^2} \cdot \text{m} = \text{nt} \cdot \text{m} = \text{joules}$$

2. Compute the kinetic energy the same car would have at 60 mph.
(Hint: Doubling the car's speed will quadruple its energy)

3. Explain why the patrolman in the following story knew the lady did not understand the relationship between speed and energy.

"A young lady was stopped by a highway patrolman for going 70 miles per hour on I-25. When the patrolman asked why she was going so fast she replied, "I'm running out of gasoline and I am in a hurry to get to the next gas station."

#2 Activity Title: "Interesting Comparisons"

Background: Energy is measured in many ways. Don't let all the units of measurement confuse you. One can make meaningful (and sometimes humorous) comparisons among various energy sources simply by converting all information to the same unit of measurement. Here are some definitions, abbreviations, and conversion factors that may help.

Time Required: 15 minutes

Materials: Overhead projector, spirit master

Procedure:

1. Make a transparency of Table 1 and a spirit master of "Interesting Comparisons".
2. Work through the problems with students.

Reference: Adapted from Energy and Society, BSCS, 1977. p. 71.

Table 1.

CONVERSION FACTORS		
To convert from:	To:	Multiply by:
kilowatt-hour	Btu	3,412.8
ton bituminous coal	Btu	26,200,000
bbl crude oil	Btu	5,600,000
bbl residual oil (No.5)	Btu	6,290,000
gallon gasoline	Btu	125,000
gallon No. 2 fuel oil	Btu	138,800
cubic foot natural gas	Btu	1,031
Mcf natural gas	Btu	1,031,000
therm natural gas	Btu	100,000
gram calories	Btu	.00397
kilogram calories	Btu	3.97
cubic ft atmospheres	Btu	2.721
foot-pounds	Btu	.001284
horsepower-hours	Btu	2,546.14
horsepower-years	Btu	22,304,186.4
Langleys	Btu/sq.ft.	3.69
Btu	cubic centimeter	
	atmospheres	10,405.6
Btu	cubic foot	
	atmospheres	.36747
Btu	foot-pounds	777.694
horsepower	ft.-lb./sec.	550
horsepower	ft.-lb./min.	33,000
horsepower	ft.-lb./hour	1,980,000
Btu	gram calories	251.9958
Btu	kilogram calories	.2519958
Btu	horsepower-hours	.0003927
kilowatts	horsepower	1.34124
horsepower	kilowatts	.7547
horsepower	watts	754.7
Btu/sq.ft.	Langleys	.271
Btu	kilowatt-hours	.000283

Interesting Comparisons

Problem 1. One gallon of milk provides about 2640 kilocalories (Calories) or about 10,480 Btu's. How many gallons of milk would you have to drink to get as much energy as your car gets from one gallon of gasoline.

Problem 2. A 225 H.P. car consumes 225 H.P. hours of energy in one hour of driving or roughly 2,550 Btu's/H.P. hour x 225 H.P. hour = 573,750 Btu's.

If this car were to run on:

- a. gasoline, how many gallons would it take?
- b. coal, how many tons would it take?
- c. electricity, how many kilowatt hours would it take?

#3

Activity Title: "Stay Tuned"

Background: Table 1 gives the average loss in efficiency of an automobile that appears to be running properly but actually may have one or more of the problems listed.

Time Required: 30 minutes

Materials: Overhead projector/chalkboard/spirit master

Procedure:

1. Make spirit masters of Table 1 and "Out of Tune".
2. Work through each problem with students.

Reference: Computations About the Sources and Conservation of Energy,
Florida State Energy Office, 1977. pp. 24-25.

Table 1.

PROBLEM CAUSE	LOSS MILES PER GALLON	LOSS KILOMETERS PER LITER
POORLY ADJUSTED CARBURETOR	3	1.3
MISFIRING SPARK PLUG	2	0.85
IGNITION OUT OF TIME	2	0.85
DIRTY AIR FILTER	1	0.42
WORN BREAKER POINTS	2	0.85

Out of Tune

Using the data on the transparency (Table 1), solve the following problem:

Assuming that the average automobile in the United States is driven 12,000 miles (19,308 kilometers) in a year and averages 15 miles per gallon (6.4 kilometers per liter), determine the following:

- The number of kilometers per liter of fuel lost by an automobile having a spark plug that is misfiring.
- The number of miles per gallon of fuel lost by an automobile having a poorly adjusted carburetor.
- The number of gallons of gasoline wasted in a year by an automobile having its ignition system out of time and a dirty air filter.
- The amount of money wasted by the automobile in Problem c. if gasoline costs 65¢ per gallon.
- The number of gallons of gasoline wasted each year by an estimated 2,000,000 cars that have a combination of problems resulting in an average loss of 3 gallons per mile.
- The amount of money wasted in one year by the 2,000,000 automobiles in Part e. above.

#4

Activity Title: "Assume"

Background: The use of energy for transportation and in homes accounts for 44 percent of our total energy consumption. Thus, by reducing personal energy consumption in these two areas, individuals can make an important contribution toward reducing the total U.S. energy consumption. Table indicates 1978 energy consumption by sector.

Table 1

United States Energy Consumption (1978 Data)

19.9 percent for Commercial Uses	17.6 percent for Residential Uses
36.1 percent for Industrial Uses	26.4 percent for Transportation

As you can see from Table 1, 26.4 percent of the nation's energy is used for transportation. Since most of this is consumed in private automobiles in the form of gasoline, it is clear that reducing the use of gasoline will have a significant impact in easing fuel shortages.

Time Required: 15 minutes

Materials: Chalkboard

Procedure:

1. Copy Table 1 onto chalkboard.
2. Encourage students to think about reducing gasoline consumption on a large scale by asking them to assume they are planners for the State Department of Transportation:

Would they encourage mass transit? Why? How?

How should highways be designed to conserve energy? For safety?

Would you recommend a right turn on red after stop? Why?

What would you want the speed limit to be on interstate highways?

Reference: U.S. Department of Energy, and Energy Conservation, Energy and Man's Environment, 1977. p. 81.

#5

Activity Title: "PMPG"

Background: A useful measure of transportation efficiency is the concept of passenger-miles per gallon (PMPG). This index is determined by multiplying the number of passengers transported in a vehicle by the distance they are transported, and dividing this product by the number of gallons of fuel consumed. The larger the quotient, the more efficient the carrier.

Time Required: 20 minutes

Materials: Spirit master of Worksheet 1.

Procedure:

1. Make a spirit master of Worksheet 1.
2. Explain Table 1 and the concept of PMPG.
3. Allow students to fill in the blanks of Table 2.

Reference: Adapted from "Transportation and the City", NSTA PEEC, 1976.
pp. 4, 18.

Worksheet 1. Modes of Transportation

TABLE 1. Mileages of Various Modes of Transportation

MODES OF URBAN TRANSPORTATION	FUEL MILEAGE (MPG = miles per gallon)
Automobiles	12 MPG
Bus	3.3 MPG
Commuter Train	.1 MPG
Jet Aircraft	.25 MPG

TABLE 2 PMPG

Mode of Transportation	#of people	Length of trip	MPG	Fuel needed for trip (in gallons)	(Passengers x miles)/gallon (PMPG)
Car	1	20 mi.	12	1.67	11.98
Car	2	20 mi.	12	1.67	23.95
Car	4	20 mi.	12		
Bus	5	20 mi.	3.3		
Bus	20	20 mi.	3.3		
Bus	40	20 mi.	3.3		
Train	1,000	20 mi.	.1		
Airplane	100	20 mi.	.25		

Questions:

1. Which is the most efficient people carrier?
2. The least?
3. Which is the most popular mode of transportation? Why?
4. Rank them from 1 - 8 with 1 being the most efficient.

DAY III ACTIVITIES

HOME ENERGY

You will need to choose approximately 30 minutes of support activities from the following list.

Objective:

The student will be able to use scientific principles and mathematical operations in energy consumption and conservation applications related to the home environment.

#1

Activity Title:

"Insulation and Savings"

Background: The greatest amount of energy used in a home (41%) is for keeping the house at a comfortable temperature. Therefore, proper insulation of the house is the most important energy-saving factor.

Time Required: 20 minutes

Materials: Spirit master

Worksheet 1

Procedure:

1. Duplicate Worksheet 1
2. Work through the problems with students.

Reference: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. pp. 32-33.

Worksheet 1

Insulation

Insulation in the ceiling does the most good per square foot of area. Up to 25 percent of heat loss and 40 percent of heat gain occurs through the ceiling. Just 3 inches of good insulation in the ceiling provides an average fuel saving of 26 percent.

Two inches of insulation in the exterior walls of a house will reduce fuel consumption by an average of 8 percent.

Suppose your central air conditioner uses an average of 2,000 watts of power per hour.

- a. Compute the number of kilowatt-hours of energy used during 1 month (30 days). (1 kwh = 1,000 watts)
- b. At the rate of 3.6¢ per kilowatt-hour, determine the cost of operating the air conditioner for 1 month.
- c. Suppose you insulate your ceiling with 3 inches of good insulation. Determine the savings on the cost of air conditioning your home for 1 month.
- d. Two inches of insulation in the exterior walls of a house will reduce fuel consumption by an average of 8 percent. Determine the savings on the cost of air conditioning your home each month if only your walls were insulated.
- e. Assuming you had both ceiling and wall insulation, calculate the cost of air conditioning your home for 1 month.

#2

Activity Title: "How Quickly Does It Cool?"

Background: Heat lost by conduction is directly proportional to a temperature difference (the driving force) and inversely proportional to the thermal resistance of the insulating medium.

Time Required: 30 minutes

Materials: Small Box

Thermometer

Insulating materials

Chalkboard

Procedure:

1. Place a thermometer in a glass of hot water or coffee. Read the temperature every five minutes.
2. Have your students help you make a graph of temperature vs. time on the chalkboard. Now, put a fresh glass of hot water or coffee inside a box and pack cotton balls, fiberglass insulation, or crumpled paper around it.
3. Make a graph of temperature against time as before and compare with the previous case; the effects of the insulation will be obvious.
4. If time permits, have students "invent" their own insulation material.

Repeat step 3.

Reference: Energy In the Classroom, Virginia Energy Office, 1975. p. 69.

#3

Activity Title: "A Shortage of Energy?"

Background:

If energy is conserved, how is it that we can run out of it? This is a very subtle question which you will want to discuss with your students at length. The answer is that some forms of energy are far more useful than others, and energy is always degraded from more useful forms to less useful forms. We don't run out of energy. We run out of useful energy.

A very useful form of energy is the chemical energy stored in oil. A relatively useless form of energy is the heat energy stored in a large body of matter just a few degrees above the outside temperature. The ocean, for example, contains a vast amount of energy in the form of heat. If you could build, say, a submarine which would take in sea water, extract heat energy from the water, and use this energy to turn the ship's propellers, then there would be no energy crisis at all.

Submarines, or anything else, could simply run on the heat in the air or water around them. Unfortunately, such a submarine is impossible. A temperature difference is necessary to enable us to build an engine which will convert heat energy into useful work. The temperature difference must be large if the engine is to be efficient.

Since a temperature difference is necessary if we are to convert heat into work, and the larger the difference the more efficient the conversion, we can see that heat stored at a temperature much higher than that of its surroundings is potentially more useful than heat stored at temperatures closer to those of its surroundings. Since heat always tends to flow to cooler areas, however, and temperature differences always tend to gradually disappear, we see that heat energy tends to become degraded with time.

This is a very general principle -- all forms of energy tend to become transformed into less useful forms as time goes on. Fortunately, the process is sometimes very slow indeed.

The physical principle involved in the degradation of energy is the second law of thermodynamics. It is one of the most thought-provoking of physical laws and one on which innumerable books and articles have been written.

Time Required: 10 minutes

Materials: None

Procedure:

1. Discuss the question: "If energy is conserved, how is it possible that we can run out of it?"
2. Use a textbook definition of the Second Law of Thermodynamics to stimulate discussion concerning the degradability of energy.

Reference: Adapted from Energy In The Classroom, Virginia Energy Office, 1975. pp. 71-72.

#4

Activity Title: "Not So Hot!"

Background: Heating water is the second largest source of energy in the home environment (9%).

Time Required: 30 minutes

Materials: Worksheet I

Chalkboard

Procedure:

1. Make a spirit master of Worksheet I below.
2. Work through the problems with your students.
3. This activity can be demonstrated with an inexpensive immersible "coffee warmer".

Reference: Adapted from Energy In The Classroom, Virginia Energy Office, 1975. p. 69.

Worksheet I
Heating Water

The unit we will use for energy is the kilowatt hour (kwh), which is the quantity of energy used when a device rated at 1000 watts operates for an hour (or a 100 watt appliance operates for 10 hours). Below are various energy equivalents:

<u>Process or Unit</u>	<u>Number of KWH</u>
Calorie (diet, or kilocalorie)	.0012 (1.2×10^{-3})
calorie (gram-calorie)	1.2×10^{-6}
British Thermal Unit	2.9×10^{-4}
1 hour of manual labor	.06
Combustion of 1 gallon of gasoline	38.3
Heating 1 gallon of water 1°F	2.4×10^{-3}

Example:

Compute how long it will take a 25 amp, 240 volt water heater to heat 60 gallons of water from 60°F to 180°F . To do the computation, follow these steps:

Energy required to heat 60 gallons 1°F
 $= (60) (.0024) = .144 \text{ kwh}$

Energy required to heat from 60°F to 180°F (change is 120°F)

$= (.144 \text{ kwh}) (120) = 17.3 \text{ kwh}$

Rate at which heater can deliver energy

$= (\text{volts}) (\text{amperes})$

$= (240) (25) = 6000 \text{ watts}$

$= 6.0 \text{ kilowatts}$

Thus the number of hours is:

$\frac{17.3}{6.0} = 2.9 \text{ hours, or 2 hours and 54 minutes}$

Many people who bathe use 3 inches of water in a tub and feel that it is adequate. Some people fill the tub to a 12-inch depth.

1. How much electric energy is required to bathe in this type of luxury?

Assume the water is heated from 4.5°C to 38.0°C and that 1.2×10^{-6} necessary to raise 1 cc of water 1°C .

Assume also that a tub containing water at a depth of 12 inches contains 200,000 cc of water.

(Note: 1 cubic inch = $(2.54)^3$ cubic centimeters)

Compute the watt-hours of electricity as follows:

$$\begin{aligned} (\text{watt-hours}) &= 1.2 \times 10^{-6} \times \Delta^{\circ}\text{C} \times \text{Volume} \\ &= 1.2 \times 10^{-6} (38.0 - 4.5) (200,000) \\ &= \underline{\hspace{2cm}} \text{kilowatt-hours.} \end{aligned}$$

2. How long would this amount of energy operate a 60 watt bulb?

Note: Some useful conversion factors are:

Number of watts = volts x amperes

1 kilowatt (kw) = 1000 watts = 10^3 watts

1 megawatt (mw) = 1,000,000 watts = 10^6 watts = 10^3 kilowatts

1 horsepower (hp) = 746 watts = .746 kilowatts

#5

Activity Title: "Keep on Truckin"

Background: Energy is the ability to do work. The amount of energy needed to perform work is: $\text{WORK (Energy)} = \text{Force} \times \text{Distance}$.

Power is the time rate of doing work or

$$\text{POWER} = \frac{\text{WORK (energy)}}{\text{Time}}$$

Time Required: 20 minutes

Materials: 1. Flight of stairs

2. Stop watch

3. Meter stick

Procedure:

1. Choose the largest boy and girl in class to "collect data". Ask them to go to the nearest stairwell and measure the vertical height from one landing to the next floor up.
2. Each should time the other as they run up the stairs as fast as they can, then report back to class.

3. In the meantime, discuss the following with the class:

The vertical distance traveled multiplied by one's weight gives the energy required to move him upstairs. Divide this energy by the time in seconds for the climb to get power output.

In the metric system, for example, a boy of mass 58 kg. weighs 568 newtons. If he runs up a vertical distance of 4.7 meters, the work he has done, or the amount he has increased his potential energy is 2,670 joules. If he runs up in four seconds, his power output is $2670/4$ or 668 joules/sec or 668 watts. Since there are 746 watts to a horsepower, the boy has generated $668/746$ or .895 horsepower.

4. When the students return to class, record the following data on the

chalkboard:

<u>Student #1</u>	<u>Vertical Distance</u>	<u>Student #2</u>
(wt. in lbs.)	_____ meters	(wt. in lbs.)
(climbing time in seconds)		(climbing time in seconds)

5. Help everyone determine the power ratings of each by working through the following computations:

(wt in lbs) x $\frac{1 \text{ kg}}{2.2 \text{ lbs.}}$ x $\frac{9.8 \text{ newtons}}{\text{kg}}$ = _____ newtons of force required to move body.

_____ newtons x _____ meters = _____ newton-meters or joules of energy.

_____ joules $\div$ _____ seconds = _____ joules/sec or watts

_____ watts $\div$ 746 watts/horsepower = _____ HP

This experiment should suggest a variety of questions for discussion:
What forms of energy are involved here? Does the experiment illustrate the concept that energy is the ability to do work? Which student has the greater power rating for maximum output?

Reference: Adapted from Energy In The Classroom, Virginia Energy Office, 1975. p. 67.

SCIENCE

DAY IV ACTIVITIES

APPLIANCES

You will need to choose approximately 30 minutes of support activities from the following list.

Objective:

Students will be able to apply physical science concepts to the solution of problems involving the energy consumption of household appliances.

#1

Activity Title: "Watt's a Watt?"Background:

Electrical power is determined by volts (electrical pressure) and amperes (current flow) working as a team. Neither term by itself gives a measure of electrical power for turning motors or producing heat or light. For example: If you have 50,000 volts available but no free electrons to flow (amperes) there can be no power. Or, if you have enough free electrons in a circuit to provide a flow of 1,000 amperes, there will be no power unless there is sufficient voltage to make them flow. But, if you combine 50,000 volts and 1,000 amperes, you have power enough for a small town.

In order to get a measure of power, simply multiply the two together to get a new term - watts.

$$\text{Volts} \times \text{Amperes} = \text{Watts}$$

$$\begin{array}{c} \text{(Electrical} \\ \text{Pressure)} \end{array} \times \text{(Current Flow)} = \text{(Power)}$$

SAMPLE PROBLEM

How many watts of power are available from 2 amperes flowing through a 115 volt circuit?

SOLUTION

Since power in watts = volts x amperes,

$$\text{power} = 115 \times 2$$

$$\text{power} = 230 \text{ watts}$$

Time Required: 30 minutes

Materials: Spirit master

Procedure:

1. Make a spirit master of Worksheet 1.
2. Explain the volt-ampere-watt relationship.
3. Work through problems with students.
4. This concept can be demonstrated by wiring a circuit with an appliance, ammeter and voltmeter.

Reference: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. pp. 27 - 29.

Worksheet 1

1. A room heater is rated at 1,650 watts. If you plug it into a 115 volt circuit, how many amperes are needed to operate the heater?
2. Suppose you have a 230 volt circuit with a current flow of 4 amperes. Determine the number of watts in the circuit.
3. Suppose you have a hair dryer plugged into a 110 volt circuit. If the dryer draws 11 amperes of current, determine the power rating of the dryer.
4. An electric motor rated at 2 H.P. is plugged into a 230 volt circuit. Determine the number of amperes of current required to operate the motor. (746 watts = 1 H.P.)

If you get a part-time job, you will probably be paid by the hour. You pay for electrical energy in the same way. For example: Suppose you are operating a 1 H.P. motor, fully loaded, for 10 hours. (Remember 1 H.P. = 746 watts.) Multiplying 746 watts by 10 hours, you get 7,460 watt-hours. Watt-hours are such small units of electrical energy that power suppliers such as Public Service Company of Colorado and Colorado REA's sell them to you by the 1,000. Each unit of 1,000 watt-hours is called a kilowatt-hour (kwh).

5. Calculate the number of kwh's used to operate the hair dryer in Problem 3 for 5 hours.
6. At \$.0362 per kwh compute the cost of operating the hair dryer for one hour in Problem 3.

#2

Activity Title: "Can You Read It?"

Background:

To read an electric meter (Kwh's), follow these rules:

1. Read the dials from right to left, and write down the answer from right to left.

2. When the dial is between two numbers, read the smaller number.

Special Note: The rotating wheel:

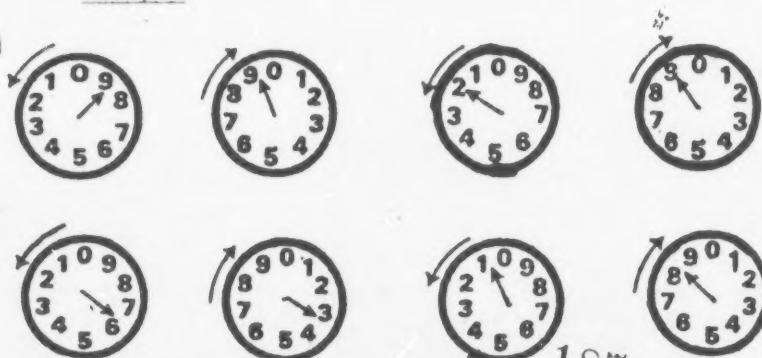
The speed at which the disk is rotating depends on how much power you are using, but -- be careful -- different meters turn at different rates. There is a simple rule which enables one to calculate how much power is used from how fast the disk is rotating. A number -- such as 7.3 Kh-is written on the meter. It tells you the energy in kilowatt hours represented by 1,000 turns of the disk. Multiply this number by 3,600 and divide by the number of seconds for one revolution of the disk and you get the power passing through the meter.

Time Required: 15 minutes

Materials: Chalkboard

Procedure:

1. Draw simulated meter dials on the chalkboard and ask students to interpret them.

Example:

February
8929 Kwh

January
6308 Kwh

Difference = 2621 Kwh's

2. Determine the cost at \$.0362 per Kwh.
3. Discuss the following questions:
 - a. Why is it important to know how to read a utility bill?
 - b. How many times a month do your parents receive a bill?
 - c. What does your electric or gas bill tell you?
4. If time permits, allow students to read the school's meters.

Reference: Adapted from Energy In the Classroom, Virginia Energy Office,
1975. p. 68.

#3 Activity Title: Operating Costs of Appliances"

Background:

Public Service Company of Colorado presently charges \$.0362 per Kwh for electricity. One thing is certain: we can expect to pay more for electricity (and natural gas) in the future - and energy costs will represent a greater proportion of the household dollar budget.

The cost to operate a given appliance may not appear to be a great expenditure; taken collectively, the cost of operating a household full of electrical appliances may surprise you.

Note: A Kwh (kilowatt hour) is equivalent to the electricity used by ten 100-watt light bulbs burning for one hour.

Time Required: 20 minutes

Materials: Spirit master of Fig. 1

Procedure:

1. Make spirit masters of Fig. 1.
2. Discuss Fig. 1 briefly, pointing out the high-consumption appliances.
3. Ask students to check (✓) those appliances which they have in their homes. (If more than one appliance of the same kind is owned, additional checks should be placed next to the appliance name.)
4. Instruct them to add the estimated annual costs of appliances (those checked) to determine a total annual estimated cost. (Note: Be sure students multiply by the number of each appliance owned before they add.)
5. Ask each to calculate the percent of his family's annual income that must be spent for operating electrical appliances.
6. Elicit student suggestions for reducing this percentage.

Reference: Energy In the Classroom, Virginia Energy Office, 1975. pp. 52-54.

Fig. 1. ANNUAL ELECTRIC ENERGY USE AND COST

Appliance	Average Power (Watts)	Annual Consumption (Kwh)	Annual Cost, \$
Air cleaner	50	216	\$ 7.82
Air conditioner (room, 1 ton)	997	1,500**	54.30
Blender	386	15	.54
Broiler	1,436	100	3.62
Carving knife	92	8	.29
Clock	2	17	.62
Clothes dryer	4,856	993	35.95
Coffee maker	894	106	3.84
Deep fryer	1,448	83	3.00
Dehumidifier	257	377	13.65
Dishwasher	1,201	363***	13.14
Egg cooker	516	14	0.51
Electric blanket	177	147	5.32
Fan (attic)	370	291	10.53
Fan (circulating)	88	43	1.56
Fan (window)	200	170	6.15
Floor polisher	305	15	.54
Freezer (15 cu. ft. manual defrost)	341	1,195	43.26
Freezer, frostless (15 cu.ft)	440	1,761	63.75
Frying pan	1,196	186	6.73
Germicidal lamp	20	141	5.10
Hair dryer	381	14	.51

Appliance	Average Power (Watts)	Annual Consumption (Kwh)	Annual Cost, \$
Heater (portable)	1,322	176	6.37
Heat lamp (infrared)	250	13	.47
Heating pad	65	10	.36
Hot plate	1,257	90	3.26
Humidifier	177	163	5.90
Iron (hand)	1,108	144	5.21
Mixer	127	13	.47
Oven, microwave	1,450	190	6.88
Radio	71	86	3.11
Radio/record player	109	109	3.95
Range, with oven	12,200	1,175	42.54
Range, self-cleaning	12,200	1,205	43.62
Refrigerator/Freezer (14 cu. ft.)	326	1,137	41.16
Refrigerator/Freezer frostless (14 cu. ft.)	615	1,829	66.21
Roaster	1,333	205	7.42
Sandwich grill	1,161	33	1.19
Sewing machine	75	11	.40
Shaver	14	1.8	.07
Sun lamp	279	16	.58
TV (black and white), tube type	160	350	12.67
TV (black and white), solid state	55	120	4.34
TV (color), tube type	300	660	23.89
TV (color), solid state	200	440	15.93

Appliance	Average Power (Watts)	Annual Consumption (Kwh)	Annual Cost, \$
Toaster	1,146	39	1.41
Toothbrush	7	.5	.02
Trash compactor	400	50	1.81
Vacuum cleaner	630	46	1.67
Vibrator	40	2	.07
Waffle iron	1,146	22	.80
Washing machine (automatic)	512	103***	3.73
Washing machine (manual)	286	76	2.75
Waste disposer	445	30	1.09
Water heater (standard)	2,475	4,219	152.73
Water heater (quick recovery)	4,474	4,811	174.16

The estimated operating costs shown above are predicated on an average cost in Colorado of \$.0362 per Kwh.

** Based upon 1,000 hours of operation per year; this figure will vary widely depending on area and specific size of unit.

*** Does not include kilowatt hours for heating water.

#4

Activity Title: "More Heat Than Light"Background:

"Wattage" is not a measure of the amount of light radiated by a light bulb; instead, it indicates how much power (energy/time) is required to operate it. The illumination a bulb or tube provides is measured in lumens; this number is usually indicated on the bulb package. Using bulb/tube packages, compare several incandescent and fluorescent bulbs for efficacy (lumens per watt).

For example: A 100-watt incandescent bulb may yield 1750 lumens, giving the bulb an efficacy of _____ lumens per watt.

$$1750 \text{ lumens} / 100 \text{ watts} = 17.5 \text{ lumens/watt}$$

Time Required: 15 minutes

Materials: 1. Incandescent bulb and fluorescent tube cartons.
2. Chalkboard

Procedure:

1. Define the term "efficacy" as: $\text{Efficacy} = \frac{\text{Illumination (lumens)}}{\text{Power (watts)}}$
2. Using the lamp cartons, determine the number of lumens associated with the following:
 - A. 100 watt fluorescent bulb: _____ lumens
 - B. 40 watt fluorescent bulb: _____ lumens
 - C. 100 watt incandescent bulb: _____ lumens
 - D. 25 watt incandescent bulb: _____ lumens
3. Help students answer the following questions:
 1. Which type of lighting appears more efficient, incandescent or fluorescent?
 2. Is it more efficient to buy four 25-watt or one 100-watt incandescent bulbs?

3. Using the bulb costs stamped on the packages, determine the cost per lumen of A-D.
4. If time permits, demonstrate several different kinds of lamps.

Reference: Adapted from Energy Conservation in the Home - An Energy Education/Conservation Curriculum Guide for Home Economics Teachers, prepared for the Energy Research & Development Administration by the University of Tennessee Environment Center and the College of Home Economics in Knoxville.

#5 Activity Title: "Calculating the Cost of Energy Waste"

Background: Nearly 50% of this country's energy production is unavailable for further use and, as such, is "wasted". In 1977, the U.S. "wasted" more energy than Japan used! It is important for students to know how to calculate the cost of the energy wasted in their homes.

Time Required: 20 minutes

Materials: Chalkboard

Procedure:

1. Copy the following conversion factors onto the chalkboard:

1,000 watts (w) = 1 kilowatt (kw)

1,000 w for 1 hour = 1 kilowatt-hour (Kwh)

1 Kwh in Colorado costs \$.0362

2. Copy the following problem onto the chalkboard:

The Jones family is a high-consumer of electricity. During August, an inventory of their household electrical consumption yielded the following unnecessary uses of electricity:

- a. 2,500 watts for 50 hours for lighting (no one occupying illuminated areas).
 - b. 500 watts for 300 hours for air conditioning (no one at home).
 - c. 300 watts for 50 hours for television (no one watching).
 - d. 90 watts for 60 hours for radio (no one listening).
 - e. 4,600 watts for 12 hours for clothes dryer (1/2 loads)
3. Help students answer the following question:
How much money did the Joneses spend in August for the careless usage of electricity?
 4. Have students estimate hours of unnecessary use of electricity during one day in their own homes, if time permits.

Reference: Adapted from Energy Activities for the Classroom, Coon & Alexander, ERIC Center, 1976. p. 63.

DAY V ACTIVITIES

FUTURE ENERGY

You will need to choose one culminating activity from the following list.

Objective:

The students will realize the need to conserve fossil fuels while research and development can occur in alternative energy technologies.

#1

Activity Title: "Energy For Our Future"

Background: Between now and the year 2000 the United States will consume more energy than it has in its entire history. By the year 2000 the U.S. annual demand for energy in all forms is expected to more than double, and the worldwide annual demand will probably triple.

If these projected increases are realized, our ability to meet our energy demand will be taxed indeed. We must examine carefully the necessity of these increases in relation to our quality of life. Then we must develop and utilize technically feasible options which are also practical, economical, environmentally and socially acceptable. The following is a list of some of our alternative energy sources for the future.

Time Required: 15 minutes

Materials: Spirit masters "Alternative Energy Sources" and "Problems/Solutions"

Reference: Adapted from "Other New Energy Resources" and Problems/Solutions", The Energy Challenge, FEA, 1976.

SCIENCE

DAY V ACTIVITIES

FUTURE ENERGY

You will need to choose one culminating activity from the following list.

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If these projected increases are realized, our ability to meet our energy demand will be taxed indeed. We must examine carefully the necessity of these increases in relation to our quality of life. Then we must develop and utilize technically feasible options which are also practical, economical, environmentally and socially acceptable.

The following is an annotated list of some of our alternative energy sources for the future.

IF THIS ENERGY SOURCE IS USED, IT ...	SOLAR 	NUCLEAR 	WIND 	GEO- THERMAL 	COAL GASI- FICATION 	COAL LIQUI- FACTION 	OIL SHALE 	PYROLY- YSIS 
<u>5</u> WOULD HELP SOLVE THE PROBLEM OF SOLID WASTE DISPOSAL.								✓
____ COULD POLLUTE WA- TER.								
____ WOULD CONSERVE THE DWINDLING RESERVES OF FOSSIL FUELS.								
____ COULD DAMAGE WILDLIFE OR THEIR HABITAT.								
____ WOULD BE DIFFICULT TO STORE AND TRANS- PORT.								
____ WOULD NOT POLLUTE THE ATMOSPHERE.								
____ WOULD DISRUPT THE NATURAL USE OF LAND SURFACES.								
____ WOULD NOT BE ABLE TO SUPPLY ENERGY ALL THE TIME.								
____ WOULD HAVE TO WAIT UNTIL THE TECHNOL- OGY IS DEVELOPED.								
____ WOULD USE LOTS OF WATER TO PROCESS.								
____ WILL DECREASE THE NEED FOR OIL IMPORTS.								
____ WILL MAKE LARGE AMOUNTS OF WASTE MATERIAL.								
____ WILL MAKE USE OF THIS COUNTRY'S MOST ABUNDANT FOSSIL FUEL								

#2

Activity Title: "The Bottom of the Barrel"

Background:

Energy is that which allows or causes change, force, work, movement or heat. The results of energy can be measured and its effects felt. Many people falsely assume that energy fuels will be available forever. The world's supply of energy resources are not limitless; they are being used at an ever-increasing rate by the affluent nations of the world.

Until recently, very little thought or attention has been given to what will happen when the raw materials needed to produce energy become scarce and ultimately depleted. The United States has only a small fraction of the earth's population, but consumes more than one-third of the earth's annual output of energy resources to produce the goods and services represented by our present standard of living.

Fig. 1 represents the life span of a depletable resource.

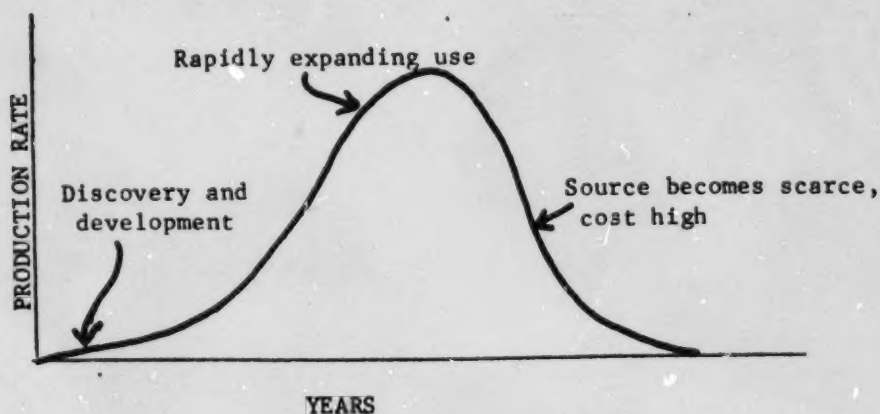


Fig. 1.

Time Required:

Materials: Spirit master "World Oil"

Procedure:

199

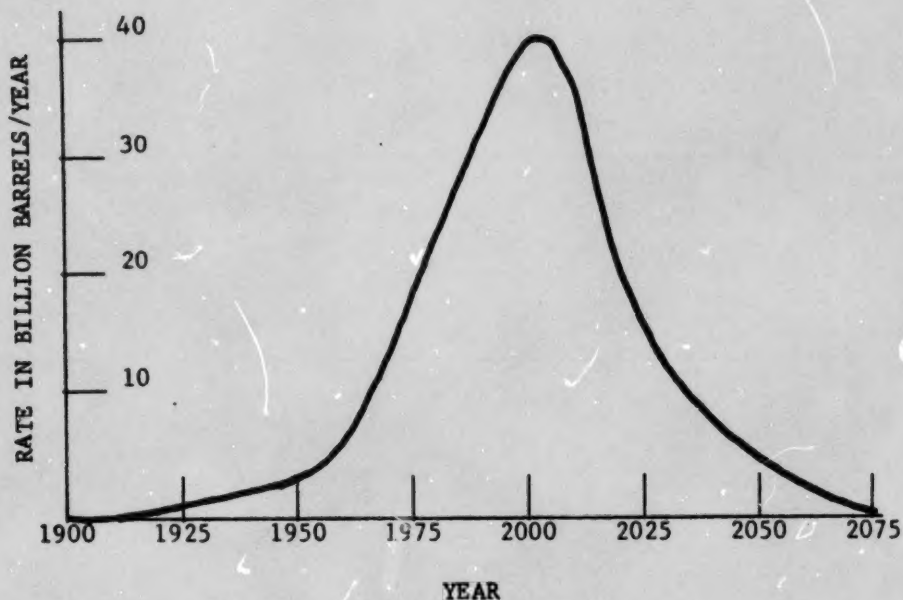
1. Make a spirit master of "World Oil".

2. Help students answer the questions below the graph.

Reference: Adapted from Energy Activities for the Classroom, ERIC/SMEAC, 1976. P. 76.

World Oil

The following graph represents an optimistic view of the life span of the world's oil resources.



After studying the graph answer the following questions.

1. When did the discovery of the use of oil for producing energy occur?
2. What is happening today in regard to the use of oil as an energy producing source?
3. How many years do we have left before world oil is totally depleted? Before economic depletion?
4. Do you feel that it is fair for a country the size of the United States to use thirty times the amount of non-renewable resources per person as another smaller underdeveloped country? Give reasons to support your answer.

#3

Activity Title: "Solar Cells"

Background: A solar cell converts sunlight directly into electricity, with no moving parts and no pollution. Fig. 1 illustrates a typical solar cell.

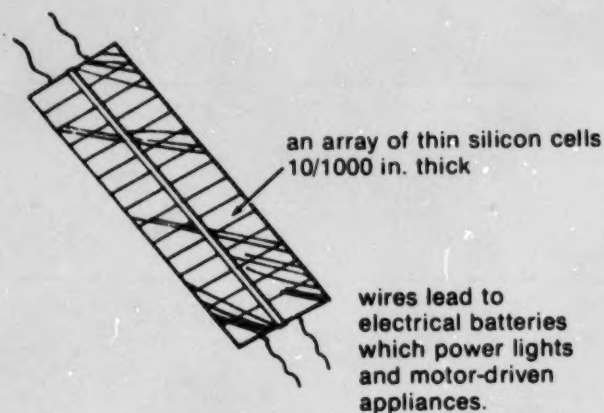


Fig. 1. Solar Cell

Time Required: 15 minutes

Materials: Solar cell, milliammeter, voltmeter, incandescent lamp (for a cloudy day)

Procedure:

1. On a board, connect the solar cell to the voltmeter and milliammeter. Take the board (and students) outside for the demonstration. Determine the best angle of the solar cell to get maximum voltage and ampere readings. Record this data.
2. Back in the classroom, have students determine the power output in watts by multiplying volts by amps. From this data, convert to kilowatts.
3. How does the power output of the solar cell compare with the wattage required by some household appliances? How does the number of kilowatts

produced compare with a typical family's monthly consumption? Could solar cells be used to power a city? A home? How much surface area of solar cells would be required to produce the power needed for a home? What factors affect the efficiency of a solar cell?

Reference: Adapted from Energy Activities for the Classroom, ERIC/SMEAC, 1976. P. 48.

1

SOCIAL STUDIES

SS-1

DAY 1 ACTIVITIES

INTRODUCTION

Choose one, two or three activities from the following list, using them to introduce students to U.S. energy problems.

Objective

The student will be able to understand the root causes of the U.S. energy dilemma and the need to conserve energy fuels.

#1

Activity Title: "Energy Resources - Yesterday & Today"

Background: We have made transitions to "new" energy fuels in the past.

Table 1 shows U.S. aggregate energy consumption in 1850, 1900, and 1978.

Time Required: 15 minutes

Materials: Chalkboard/overhead projector

Procedure:

1. Copy Table 1 onto chalkboard or overhead transparency.

Table 1. Aggregate U.S. Energy

Consumption: 1850, 1900 & 1978

ENERGY FUEL	1850	1900	1978
Wood	90.7%	21.0%	--- %
Coal	9.3	71.4	18.9
Petroleum	----	2.4	46.0
Natural Gas	----	2.6	28.4
Hydropower	----	2.6	4.4
Nuclear	----	203 ----	2.3

2. Ask students the following questions about Table 1, encouraging class discussion:

- a. Which fuel transitions do you see in the data?
- b. What do you think inspired the transition from wood to coal in the early 1900's? What effect did this have on society?
- c. What do you think inspired the transition from coal to petroleum and natural gas? What effect did this have on society?
- d. Together, petroleum and natural gas account for what percentage of current energy consumption?
- e. Petroleum and natural gas production peaked in the early 1970's. What energy source(s) do you think will replace them in the remainder of this century? Give reasons. What effects will each have on society?

References: University of Tennessee/USDOE. Energy Conservation in the Home, 1977, p.5.

American Petroleum Institute, U.S. Energy: Yesterday, Today & Tomorrow, 1977, p.5.

2

Activity Title: "From Horse to Horsepower"

Background: Animal-derived work was the major source of energy during the second half of the 19th century until the internal combustion engine began to replace animals on the farm and in the transportation sector. Table 2 compares the animal contribution to the inanimate work output in billions of horsepower hours.

Time Required: 10 minutes

Materials: Chalkboard/overhead projector

Procedure:

1. Copy Table 2 onto chalkboard or overhead transparency.

Table 2. Animate & Inanimate Work Output, 1850-1920

Year	Work Output (10^9 horsepower hours)*	
	Work Animals	Inanimate Energy Sources
1850	5.4	3.6
1860	7.6	5.9
1870	8.4	8.5
1880	11.1	16.0
1890	14.4	30.3
1900	16.9	57.6
1910	18.0	142.8
1920	15.2	268.1

* One horsepower hour is the amount of work performed (or energy consumed) by working at the rate of one horsepower for one hour; it is equal to 1,980,000 foot-pounds. (An athlete lifting a 110 lb. sack of cement five feet from the ground to a loading dock every second would have a power rating of one horsepower)

2. Explain the meaning of a horsepower (power unit) and the horsepower hour (energy unit).

$$1 \text{ horsepower} = \frac{550 \text{ ft-lbs}}{\text{sec.}}$$

$$1 \text{ horsepower-hour} = \frac{550 \text{ ft-lbs}}{\text{sec.}} \times \frac{3600 \text{ sec.}}{\text{hr.}} = \frac{1,980,000 \text{ ft-lbs.}}{\text{hr.}}$$

3. Ask students the following questions about Table 2, encouraging class discussion:

- a. Approximately what year did work output from inanimate sources overtake animal output?
- b. A transition from work animals to the internal combustion engine required changing energy fuels. What fuels were involved? What effects did this have on the average person, country and balance of power?
- c. By 1890 inanimate work output was how many times greater than work animal output? By 1910? By 1920?
- d. Do you think the trend visible in Table 2 has continued from 1920 to the present? Why or why not?
- e. What factor(s) might prevent this trend from continuing into the indefinite future?

References: University of Tennessee/USD OE, Energy Conservation in the Home, 1977, p.5.

#3

Activity Title: "To Import or Not To Import"

Background: Only two decades ago, the U.S. was a net exporter of energy; in 1974 it was importing 15% of its energy and about 35% of its oil. In 1976 we imported over 40% of our oil. As domestic oil production continues to decline, we can expect to import more oil - - until world oil becomes very scarce and very expensive in the early 1980's. Fig. 1 indicates trends in oil importation; Fig. 2 shows sources of imports, and Fig. 3 shows exponentially escalating costs.

Time Required: 15 minutes

Materials: Overhead projector

Procedure:

1. Make a transparency of Figs. 1, 2 & 3 below.

Fig. 1

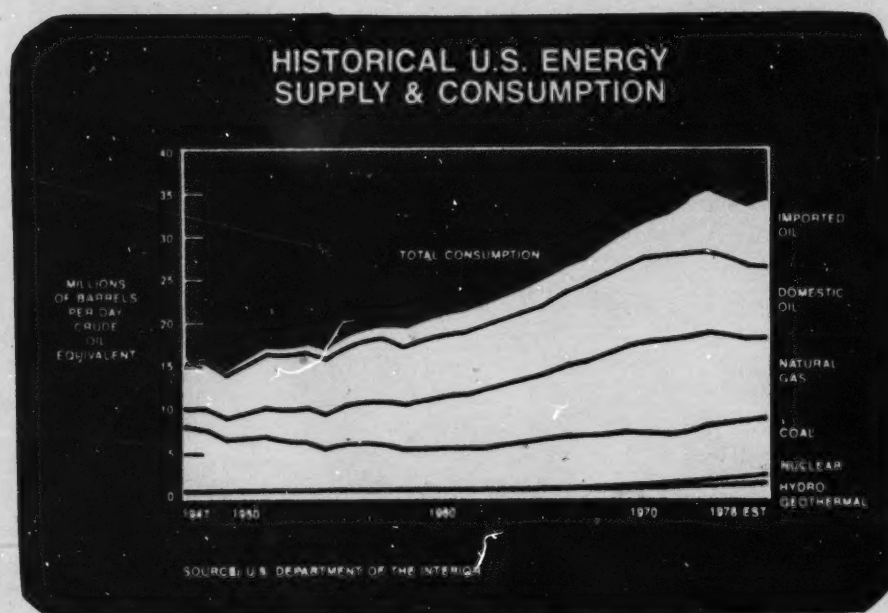


Fig. 2

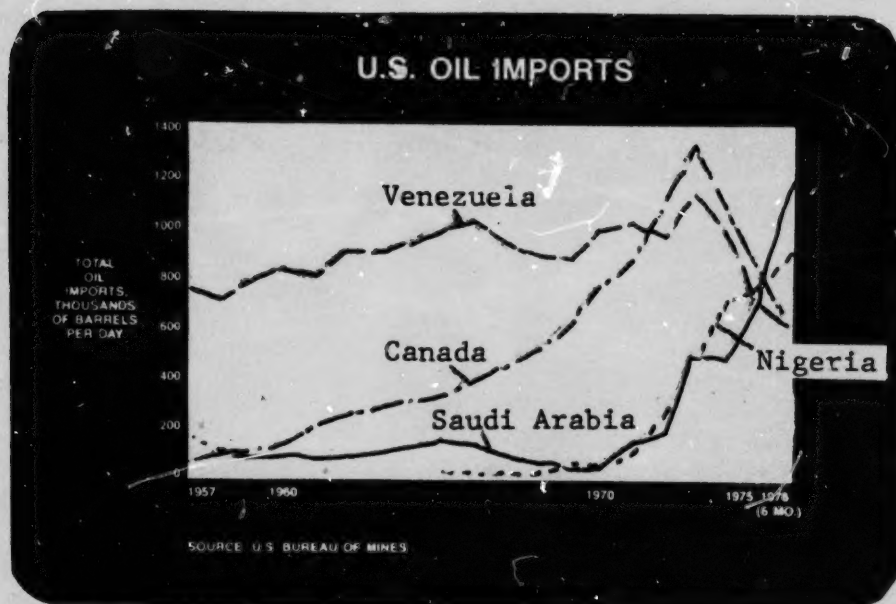
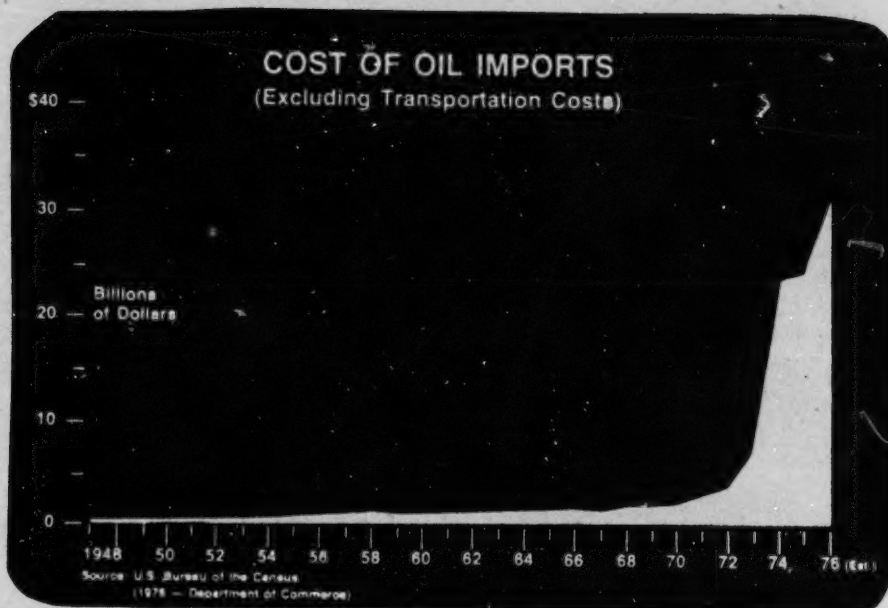


Fig. 3



2. Ask students to interpret the figures, answering the following questions:

- a. What trends are visible in Fig. 1?
- b. In 1965, which two countries were our leading sources of imported oil? (Fig. 2)
- c. Approximately how many thousands of barrels of oil per day were we importing in 1965? (Fig. 2)
- d. In 1976, which country was our leading source of imported oil? (Fig. 2)
- e. How much money was spent by the U.S. in 1976 for imported oil? From where did this money come? (Fig. 3)
- f. (Optional) How much is a billion dollars?
If you could spend \$1,000,000,000.00 at the rate of \$1,000.00 per day, how long would it take to spend it?

Reference: American Petroleum Institute, U.S. Energy: Yesterday, Today & Tomorrow, 1977, p. 6-8.

#4

Activity Title: "Our Modern Day Energy Dependency"

Background: Almost every facet of our modern society has depended upon increasing consumption of our fossil fuel resources, usually without regard to their physical limits.

Time Required: 45 minutes

Materials: Chalkboard/overhead projector

Various lengths of yarn, cord or string

Felt-tip marker or crayons

Procedure:

1. Explain to students that on April 20, 1977, President Carter, in his energy address, made several references to "quality of life", "high standards of living" and "the good life". Ask students what these expressions mean to them.
2. On a chalkboard or overhead transparency write "ELEMENTS OF THE GOOD LIFE", and ask students to brainstorm those aspects - products, services, necessities - which appear to be vital to our way of life. (Examples are: transportation system, jobs, food, petrochemicals, fossil fuels, communications, aesthetics, electrical appliances, housing, laws, sanitary services, clean air/water, industry and countless others.)
3. With the students' help refine and consolidate elements on the master list until the total equals the number of students in your class. Assign each student to play the "role" of a particular good life element, using the scrap paper to make a "name tag". Make one for yourself which reads "Government".
4. Instruct the students to stand and arrange themselves in a circle, using

lengths of yarn to connect themselves to other elements of the good life upon which they depend. After a few minutes, a web of interdependencies will emerge. Of course, nearly all of the elements are subject to governmental control and, if you are standing in the middle of the circle, you will become hopelessly entangled - much to the delight of your students.

5. When the completeness of the web becomes apparent, simulate a production crisis of the fossil fuels (or just oil and natural gas) by asking those students to carefully remove their strings from other elements which depend upon them. The result is a frightening simplification - a near collapse - of the web.

6. Discussion: In the same way that ecosystems face potential collapse due to removal of components, so does the web of good life elements when the fossil fuels are removed. Discuss the fact that the strength of our social system which depends on many apparently distinct elements is maintained by diversity, weakened by simplification and almost totally dependent on the fossil fuels.

Reference: Colorado Energy & Man's Environment

#5 Activity Title: "What's An Energy Conservation Ethic?"

Background:

Definitions of Conservation and Curtailment

Both conservation and curtailment are activities which lead to reduced energy demand. Conservation is defined as the wise use of energy which results from a rational response to price changes or a shift from less to more available fuel resources. Conservation does not connote the denial and countering of the American dream, though many people believe that this is so. Rather, conservation attempts to change citizens from being high energy users to low energy users by reinforcing "saver" values in pragmatic, money-saving terms.

Curtailment, on the other hand, is a short-run strategy that is used to cope with acute energy shortages; for example, an oil embargo would induce curtailment or cutting-back of petroleum consumption among those affected by the embargo. Curtailment requires denial.

If we conserve our energy resources now, we can postpone curtailment of these resources in the future. Conservation is a long-term necessity that should be implemented for five basic reasons:

1. Conservation saves money; lower cost material resources can often be used to achieve the same ends as high cost energy resources.
2. Conservation can expand our range of energy choices because it permits us to select those energy supply technologies that are most acceptable and reject those that are relatively objectionable.
3. Scarce energy resources can be freed for use in developing countries by conservation. The value of an incremental supply of energy in a developing country may be much greater than in a developed country.

4. The U.S. dependence on unreliable and costly supplies of foreign oil can be reduced by conservation measures.

5. Conservation measures will help provide energy resources for future generations; they will help to prevent future generations from having reduced standards of living.

A 1976 FEA conservation paper entitled "Group Discussions Regarding Consumer Energy Conservation" found that energy conservation is generally viewed as a "time-buying" strategy that will be implemented only until some new, infinite, inexpensive source of energy is found. The American society can then continue to be spoiled, self-indulgent, and extravagant. Conservation is not considered an end in itself. Many pre-teenagers romantically believe that a "Star Trek" world, with its "new" energy resources, will be theirs or at least their children's. But the "new" energy resources (fusion, for example) may not be implemented for quite a long time and when (and if) they are, will probably be more expensive than we think. Until such resources are developed, we must act with the belief that "new" resources may never be available. Thus, conservation should be considered an end in itself.

- AN ENERGY CONSERVATION ETHIC

At the present time, American society seems to emphasize materialism, and behind materialism stands the "Work Ethic"--that citizens should work as hard as possible, produce as much as possible, be as successful as possible, and buy as much comfort as possible. These attitudes have led to tremendous consumption of energy resources.

If citizens are to slow the exponential energy demand growth rate which may limit options available to future generations, they must modify their "Work Ethic" with a new ethic--a "Conservation Ethic."

Such an ethic can carry us beyond cost-saving responses to changes in our behavior--our mode of living. Teachers must make clear to their students that this new ethic is "based on a realistic comprehension that so many of the raw materials on which current living standards rely will be expended in the foreseeable future. At the present time, such a basis has a quite limited appeal to a country that is, in terms of energy, spoiled, self-indulgent, and extravagant; the ethic is unpalatable. But for the sake of future generations, teachers must awaken in themselves and their students "a moral sense of waste and greed" that will lead to the acceptance of the Conservation Ethic.

Elements of a Conservation Ethic

1. Do I really need it to be happy?
2. Will buying it help promote a more materialistic lifestyle?
3. Is it the cheapest, yet most effective in terms of total cost?
4. What resources are in it?
5. Are the resources scarce or nonrenewable?
6. From what countries do the resources come?
7. Are there other resources which could be used to make it?
8. What could be used as a substitute or alternative?
9. Did its production result in significant environmental/ecological damage?
10. Will its use result in significant environmental/ecological damage?
11. How long will it last and can it be recycled?
12. Is it efficient and safe?

Time Required: 45 minutes

Materials: Overhead projector/chalkboard

Procedure:

1. Copy "Elements of a Conservation Ethic" onto an overhead transparency.
2. Ask students to give their definitions of conservation and curtailment.
3. Using the chalkboard, list students' reasons for the need (or lack of need) to conserve energy.
4. Discuss the meaning of "ethic".
5. Present, using the overhead projector, "Elements of a Conservation Ethic".
6. Ask students to apply the list orally to a product they have been wanting for a long time. Discuss.

Reference: Adapted from Energy Conservation in the Home, University of Tennessee/ USDOE, 1977, pp. 25 - 28.

SOCIAL STUDIES

DAY II ACTIVITIES

TRANSPORTATION

Choose approximately 30 minutes of support activities from the following list.

Objective:

Students will understand the physical and social implications of the tremendous consumption of energy in the transportation sector.

#1

Activity Title: "Trucks and Planes, Buses and Trains"

Background: Most of the consumption of energy in the transportation sector is due to the movement of people and goods on U.S. highways. Oil accounts essentially for all energy consumed in this sector. Some modes of transportation are more efficient transporters than others.

Time Required: 30 minutes

Materials: Spirit master

Procedure:

1. Make a spirit master of Fig. 1.
2. Discuss the meaning of "passenger miles per gallon".
3. Assign members of the class into four groups entitled (1) automobiles,

(2) buses, (3) trains, and (4) airplanes. Assign each group the responsibility of examining carefully the data concerning the efficiency of various vehicles within their assigned mode of transportation. Each group should compare also the efficiency of their mode with the other three.

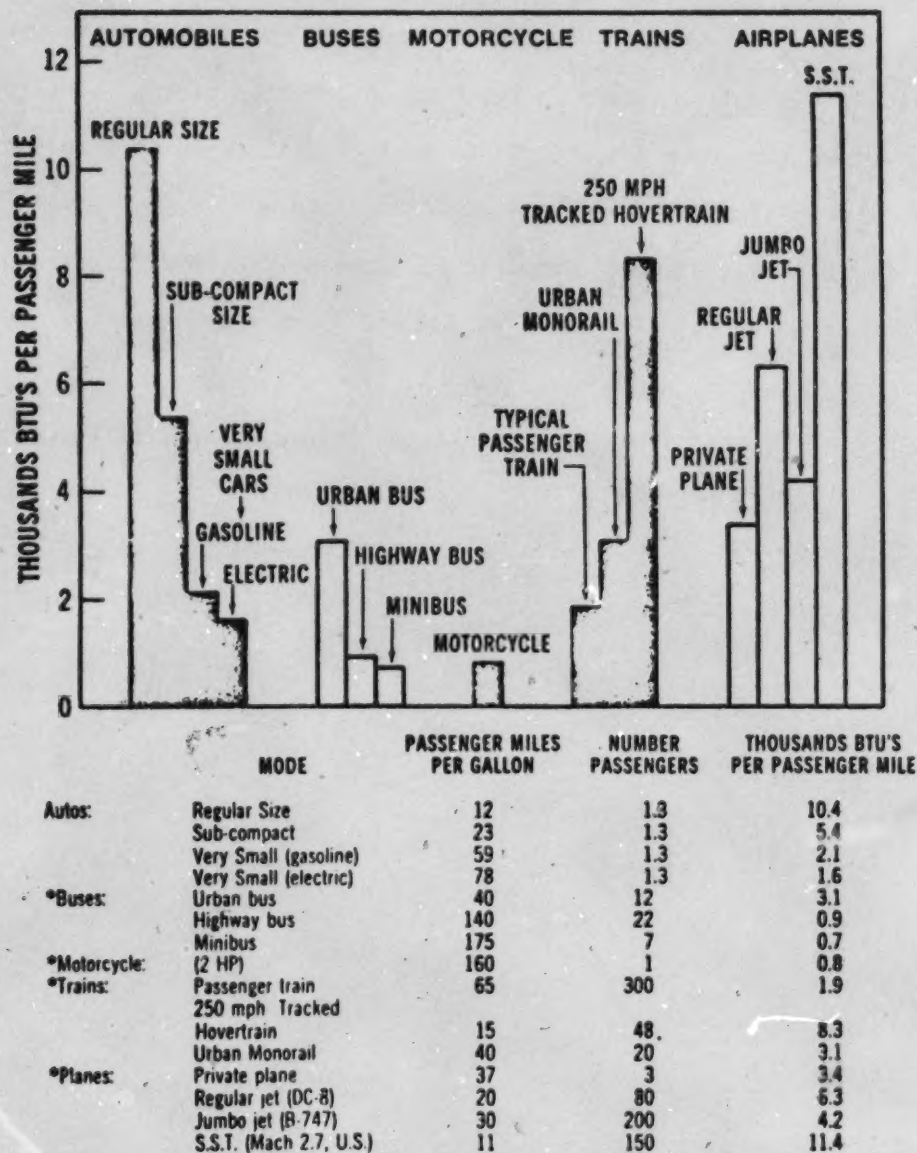
4. Each group should select a spokesperson who will explain why certain vehicles in his mode are more energy consumptive than others. The spokesperson should defend the group decision as to whether "its type" of transportation should be emphasized or de-emphasized in the future.

Note: One Btu is the energy required to increase the temperature of one pound of water 1°F . For example, it takes 300 Btu to heat one quart of tap water to boiling.

Reference: A Teacher's Handbook on Energy, Colorado Dept. of Education, Denver, Colorado 80203

Fig. 1

TRANSPORTATION ENERGY CONSUMPTION OF VARIOUS MODES



*Source: Rice, Richard A., 1972, "Energy Efficiencies of the Transport Systems;" a paper presented before the Society of Automotive Engineers at the International Automotive Engineering Congress, Detroit, Michigan, January, 1973.

#2

Activity Title: "Gasoline Rationing"

Background: The rationing of gasoline, should it occur, will ameliorate the shortage temporarily and may cause other problems.

Time Required: 15 minutes

Materials: None

Procedure:

Given the circumstance of gasoline being permanently rationed to five gallons per week, the class as a whole will discuss the personal freedoms they have now that would be modified as a result. They might also discuss all other aspects of gasoline rationing that would cause them inconvenience or change their consumer patterns.

Reference: Adapted from Energy Conservation, Energy and Man's Environment, Inc., 1977. p. 98.

#3

Activity Title: "Big Cars, Little Cars"

Background: A car weighing 5,000 pounds uses over twice as much fuel as one weighing 2,000 pounds. Accessories such as air conditioning and automatic transmission increase fuel consumption.

The average car driven at 75 to 80 mph will consume twice as much fuel as the same car driven at 50 mph.

Time Required: 15 minutes

Materials: None

Procedure:

1. Read the background statements aloud.
2. In an open discussion ask students to respond to the following questions:
 - a. How do these two statements make you feel about the size of your family car and the speed at which it is driven?
 - b. What can you do about the speed at which your family's car is driven?
 - c. How important is it to you that people drive smaller cars and drive slower?
 - d. What can you do to help others realize the problem?

Reference: Energy Conservation Packet, Iowa Dept. of Public Instruction, 1977. p. 28.

#4

Activity Title: "People Movers"

Background: Mass transit can play a vital role in conserving energy in the transportation sector.

Time Required: 20 minutes

Materials: Overhead projector

Procedure:

1. Make a transparency of Fig. 1.
2. Discuss with students the types of public transportation or mass transit systems available to U.S. cities (bus, subway, train).
3. Using Fig. 1, students should consider the following questions:
Assuming that all large cities were to develop mass transit systems:
 - a. List the fuels that would be saved. What, if any, new fuels would be used?
 - b. What jobs might be lost?
 - c. What new jobs might be created for these new transportation systems?
 - d. Economically, would it be beneficial to adopt a mass transit system in place of the present auto-dominated one?
 - e. Conservationally, would there be a sufficient reduction in fuel usage and pollution to warrant this change-over?

Reference: Adapted from Ris, Thomas F., Editor. Energy and Man's Environment: Elementary Through Secondary Interdisciplinary Activity Guide, Education/Research Systems, Inc., 2121 Fifth Avenue, Seattle, Washington 98121.

Fig. 1. Energy Consumption of Various Transportation Modes

Transportation Mode	Energy Consumption
Automobiles	55.0%
Trucks	20.0
Buses	1.0
Other (including motorcycles)	.5
TOTAL HIGHWAY TRANSPORTATION	76.5%
Airplanes	9.9%
Railroads (freight)	3.5
Railroads (passenger)	.1
Shipping (inland and coastal barges and ships)	4.8
Fuel pipelines	5.2
TOTAL TRANSPORTATION	100.0%

Source: Energy Conservation in the Home, USDOE/University of Tennessee,
1977. p. 11.

#5

Activity Title: "Gasoline and Our Life Styles"

Background: As our petroleum reserves dwindle, we can expect to pay more for petroleum derivatives. Increased costs will affect our economy in predictable ways.

Time Required: 30 minutes

Materials: None

Procedure:

1. Review with the class the fact that gasoline sells for \$1.00 or more per gallon in many European countries such as Switzerland, Holland, Denmark, France, and Great Britain.
2. Divide the class into groups of three or four students. Ask each group to develop a list of ways in which "life styles" in those countries with high gasoline costs are likely to be different from the ways people live in the U.S.A. where gasoline is cheaper than in any other highly industrialized country. Encourage the groups to think broadly (beyond the obvious, such as size of automobiles and number of superhighways). Types of family vacations, suburban sprawl, status of railroad passenger service, extent of air travel, use of recreational vehicles and many other elements of our life style can be shown to be related to energy costs.
3. Ask each group to make value judgments as to whether the life style in high-energy cost countries is worse or better than ours. Ask each group to state its conclusion with one or two specific examples and defend its position before the class.

Reference: Adapted from "Energy Conservation Teaching Resource Units",

Energy: A Teacher's Introduction to Energy and Energy Conservation,
Ohio Department of Education, 1975. pp. 10-13.

SOCIAL STUDIES

DAY III ACTIVITIES

HOME ENERGY

You will need to choose approximately 30 minutes of support activities from the following list.

Objective:

Students will understand the social/personal responsibilities and values associated with a national energy conservation effort.

#1

Activity Title: "Monitoring Electrical Consumption"

Background: In order to analyze and monitor home electrical energy consumption, it is necessary to know how to read electrical meters.

Time Required: 15 minutes

Materials: Chalkboard

Procedure:

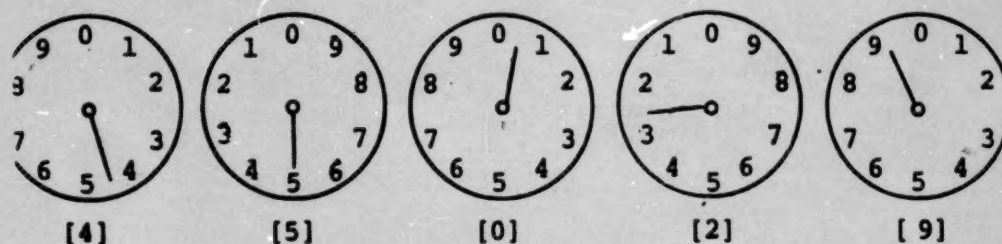
1. Explain to students how to read electric meters using Fig. 1 and the text below:

The meter contains five dials, each numbered from 0 to 9 and geared together. A special electric motor that speeds up or slows down as more or less electricity is being used turns the gears that operate the dials.

Starting from the left side the dials read values of 10,000, 1,000, 100, 10 and 1, as shown below. Dials are always read from right to left.



The pointer on each dial will usually be between two numbers. Always take the lower of the two numbers. For example, look at the set of dials below:



THESE DIALS READ 45 029 KILOWATT-HOURS

Figure 1. Example

2. Draw several sets of dials on the chalkboard to check students' ability to interpret them correctly.

3. Ask students, "Why should one family try to save electricity when their neighbors do not?" Discuss.

Reference: Public Service Company of Colorado

#2

Activity Title: "Hot Drips and Other Water Wastes"

Background: The hot water heater is the second largest consumer of energy in the home, costing the resident 9¢ of each energy dollar, and affording us the second greatest opportunity to conserve energy at home. The following techniques can save energy dollars and/or water itself:

1. When buying a new home or a replacement water heater, make sure that you have properly "sized" the tank to satisfy your needs. A four-member household can satisfy hot water requirements with one forty gallon tank.
2. Setting your water heat thermostat to 105°F - 115°F will provide water hot enough for most household uses.
3. Repairing all leaks in pipe joints and faucets saves water and energy and extends the life of your heater. For example, one hot water faucet which leaks one drop per second wastes approximately 667 gallons over the course of one year. If the water was heated from 50°F (city supply) to 150°F, about 560,000 Btu's of energy were wasted. In most cases a leaky faucet can be repaired by replacing a washer, a task taking less than fifteen minutes.

Time Required: 15 minutes

Materials: Chalkboard

Procedure:

Read the "dripping faucet" paragraph aloud to the class and pose the following questions:

- a. In the evolution of our culture, since the Industrial Revolution, what factors have led us to ignore waste of our natural resources?
- b. Why must we all act to reduce this waste now?
- c. Would a national effort to save energy resources unfairly restrict our freedoms?

Reference: Energy Information Associates, Inc., 2690 W. Main Street, Littleton Colorado 80120.

#3

Activity Title: "Who Pays More?"Background:

Different regions of the country pay more for their electrical consumption than others. The Federal Power Commission has issued its 42nd annual report, Typical Electric Bills. The book lists every community of 2500 or more in the United States and reports the average bill for five different consumption levels for 1976.

An analysis of the forty-eight contiguous states and the District of Columbia (based on a monthly consumption of 500 kilowatt hours) reveals that: New York had the highest average bill (\$36.64), Washington had the lowest average bill (\$7.58), Oklahoma had the largest increase in average bills (approximately 26.5%), and seven states had actual decreases in average bills, with Pennsylvania having the greatest decrease at 5.9%.

Time Required: 15 minutesMaterials: Overhead projectorProcedure:

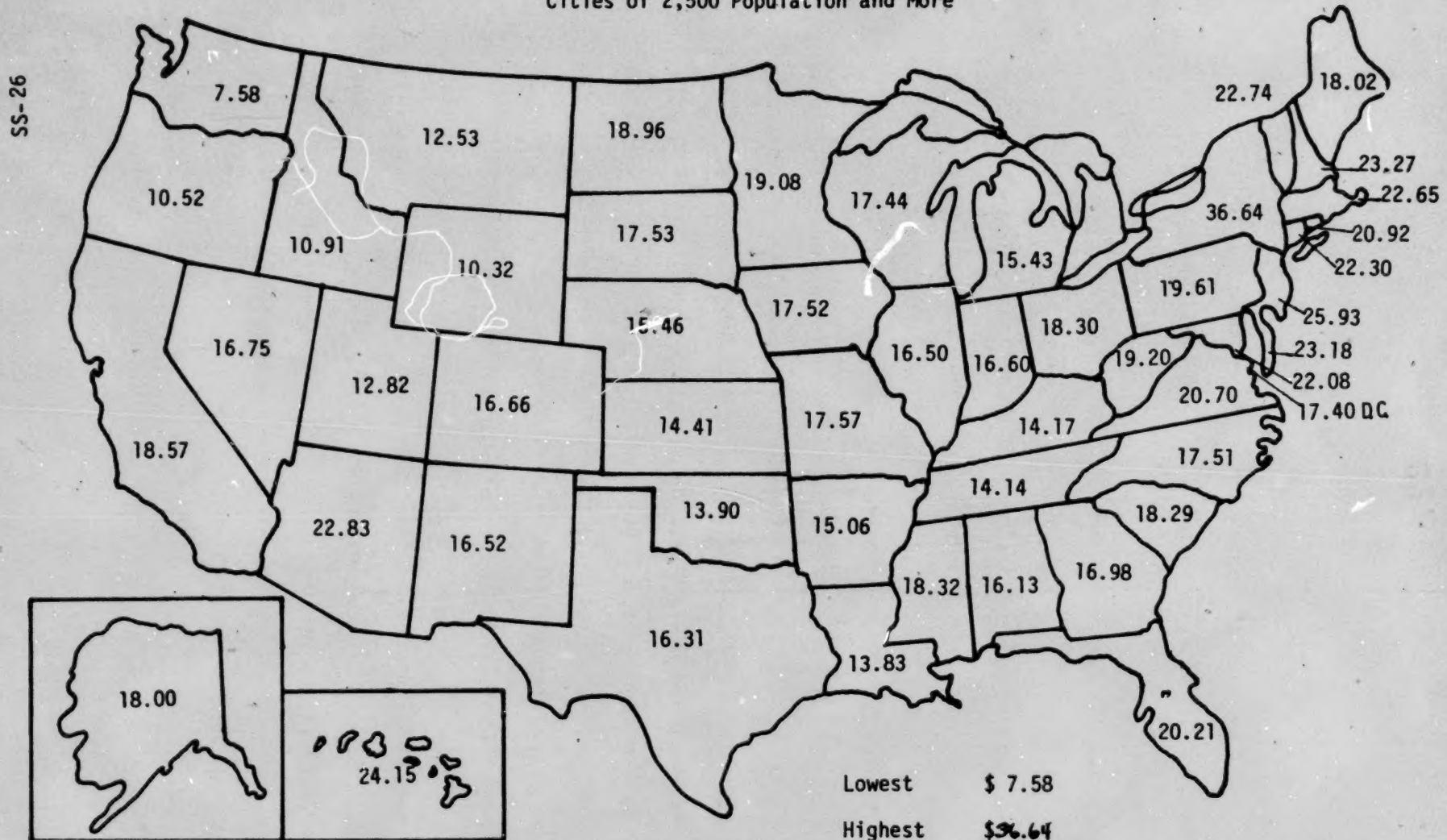
1. Make a transparency of Fig. 1.
 2. Ask students to discuss the following questions:
 - a. What trends or patterns are visible in Fig. 1?
 - b. Can you explain the patterns?
 - c. Why doesn't everyone pay the same amount for his electricity?
- Is this fair?

Reference: Adapted from Energy Conservation Activity Packets, Iowa Energy Policy Council and Dept. of Public Instruction, 1977. p. 23.

STATE AVERAGE MONTHLY BILLS* - 500 KWH RESIDENTIAL SERVICE - JAN. 1, 1976

United States Average Bill - \$19.26

Cities of 2,500 Population and More



#4 Activity Title: "What Do You Value Most?"

Background: Our current energy delinma can be traced, in part, to time-honored and tradition-enshrined values. Some of the values which we hold dear must be altered in order to reduce the consumption of fossil-derived energy fuels.

Time Required: 20 minutes

Materials: Spirit master/overhead projector

Procedure:

1. Make a spirit master or transparency of Fig. 1.
2. Ask students to rank each item according to their own values.
3. Discuss the implications of their values on energy conservation efforts and on the establishment of a viable energy ethic for the post-petroleum era.
4. Discuss how belief in one value can restrict or enhance the perception of others.

Reference: Adapted from Energy Conservation Activity Packets, Iowa Energy Policy Council and Dept. of Public Instructions, 1977. p. 26.

VALUES

Which of the following do you consider to be the most important?
Use the spaces at the bottom, and the scale, to rank the statements.

Scale: 1 = most important
10 = least important

- a. Having a large, luxurious home
- b. Breathing clean air and drinking clean water
- c. Lowering noise levels in urban areas
- d. Conserving our natural resources
- e. Having increased mobility
- f. Eliminating litter
- g. Having a high-paying job
- h. Using less energy
- i. Owning a heavy, powerful automobile
- k. Having the freedom to do whatever you choose

1. _____

5. _____

9. _____

2. _____

6. _____

10. _____

3. _____

7. _____

4. _____

8. _____

Fig. 1. Value Judgements

#5

Activity Title: "Insulation Pay-Back"Background:

The greatest amount of energy (41%) used in a home is for keeping the house at a comfortable temperature. Therefore, proper insulation of the house can be the most important energy-saving factor.

Insulation in ceilings with cold spaces above does the most good per square foot of area. Up to 25 percent of heat loss and 40 percent of heat gain occurs through the ceiling. Just 3 inches of good insulation in the ceiling provides an average fuel saving of 26 percent.

Two inches of insulation in the exterior walls of a house will reduce fuel consumption by an average of 8 percent.

As energy costs increase, the initial expense of adding extra insulation can be regained in a relatively short pay-back period.

Time Required: 15 minutes

Materials: Spirit master

Procedure:

1. Make a spirit master of Worksheet 1.
2. Work through Worksheet 1 with the students.

Reference: Adapted from Computations About the Sources and Conservation of Energy, Florida State Energy Office, 1977. p. 33.

Worksheet 1

The greatest amount of energy used in a home is for keeping the house at a comfortable temperature. Therefore, proper insulation of the house can be the most important energy-saving factor.

Insulation in the ceiling does the most good per square foot of area. Up to 25 percent of heat loss and 40 percent of heat gain occurs through the ceiling. Just 3 inches of good insulation in the ceiling provides an average fuel saving of 26 percent.

Two inches of insulation in the exterior walls of a house will reduce fuel consumption by an average of 8 percent.

As energy costs increase, the initial expense of adding extra insulation can be regained in a relatively short pay-back period. (Simple pay-back can be determined by dividing the investment cost by the first year's savings).

Directions: Fill in the blanks.

The Thompsons have decided to install insulation to reduce their winter heating bills by at least 26%. They should install at least _____ inches in the _____ of their home.

If last winter's heating bill was \$500, and if this winter is similar in severity to last, they could expect to save about _____ % or \$ _____ this winter.

If the insulation costs \$390 and if fuel costs stay the same, it would take _____ seasons to pay back their insulation investment.

Suppose the Thompsons decide not to insulate, but to place their \$390 in a savings account at 8% interest for three years. How much simple interest would their \$390 earn? (Hint: Simple interest = $\$390 \times .08 \times 3 =$ _____)

Would they save more money in 3 years by insulating or placing their money in the savings account? _____

4

SOCIAL STUDIES

SS-31

DAY IV ACTIVITIES

APPLIANCES

You will need to choose approximately 30 minutes of support activities from the following list.

Objective:

Students will be able to understand the physical and social ramifications of increased electrical consumption.

#1

Activity Title: "If You Had To"

Background: With energy costs on the increase and no end in sight, families may be faced with replacing the services provided by some electrical appliances with energy-saving alternatives.

Time Required: 10 minutes

Materials: Chalkboard

Procedure:

Ask students: "If you had to cut your energy consumption drastically, which of these could you replace easily? Which would be more difficult to replace? Which would be impossible?"

electric lighting

electric cooking

electric heat

water heating

air conditioning

mixer

washer

dryer

automobile

power lawn mower

electric toothbrush

power saw

dishwasher

television

radio

stereo system

synthetic fiber clothing

Reference: Energy Conservation, Energy & Man's Environment, 1978. p. 23.

#2

Activity Title: "Toast"

Background:

It takes energy to produce energy. Every food represents hidden sources of energy.

Net energy is the energy remainder or deficit of a system after the energy losses in changing the energy to the final form are subtracted. In other words, it takes energy to obtain energy. The energy it takes is subtracted from the final amount of energy. The remainder is the net energy value. The present U.S. food system operates on a net energy loss, (approximately 15 Cal. input to 1 Cal. output).

$$\begin{aligned}
 &\text{Total Energy Output (Calories)} \\
 &\quad - \text{Total Energy Input (Calories)} \\
 &= \text{Net Energy (Calories)}
 \end{aligned}$$

"The central question is no longer 'Can we produce enough food?' but 'What are the environmental consequences of attempting to do so?'. Agriculture expert, Lester R. Brown. ("Human Food Production as a Process in the Biosphere," Scientific American, 223, 161, 1970.)

The film, "Toast", emphasizes the resources required to produce a slice of toast.

Time Required: 30 minutes

Materials: Chalkboard, film "Toast" (Denver Public Library)

Procedure:

1. Before showing the film "Toast", discuss with students what energy inputs would be needed to produce a piece of toast. Ask them how much energy they think would be in a piece of toast.
2. Show the film, "Toast". Discuss the steps in this food system as they were shown in the film. Ask where the energy came from for all the steps.

3. Illustrate on the board that a one pound loaf of white "store bought" bread gives 450 Calories and takes 1832 Calories to produce. To find net energy input, subtract the 1832 Calories from the 450 Calories. Is there a net gain? or a net loss?

Reference: Adapted from Energy, Food and You, Washington State Office of Public Instruction, 1977. p. 156.

#3

Activity Title: "Measuring Up"

Background: It is important for students to gain an understanding of (1) how the amount of electricity used in the home is measured, and (2) the differences in energy requirements and operation costs of various household appliances.

Time Required: 30 minutes

Materials: Chalkboard

Spirit master of Fig. 1.

Procedure:

1. Define the terms needed to understand the measurement of electricity consumption in the home (watt, kilowatt, kilowatt hour). From an electric company bill determine the average cost of a kilowatt-hour (KWH) for your area. (e.g., \$.0362 per Kwh in Public Service Company of Colorado service territories.)

1 ampere x 1 volt = 1 watt

1000 watts (w) = 1 kilowatt (kw)

1 watt for one hour = 1 watt-hour (wh) = .001 Kwh

1000 watts for one hour = 1 Kwh

1 Kwh costs \$.0362

*2. Have students examine the table of "Average Wattage of Electrical Appliances", Fig. 1., and then compute what it costs in their own homes to:

- a. Leave a 100-watt light bulb burning for 6 hours.
- b. Use the vacuum cleaner for 2 hours.
- c. Use all burners of the oven and range for 3 hours.
- d. Use a dishwasher for 1 hour every day for 30 days.
- e. Run an electric clock for 1 year.

* Before students begin the computations, ask them which of the five they would volunteer to pay for out of their allowances.

A variety of other simple calculations (appropriate for the class) could be devised to illustrate the relative cost of household appliances:

Reference: Adapted from Living With Electricity, Columbus & Southern Ohio Electricity Company, 1967. Activity suggested by James M. Richmond, Doctoral Student in Science Education, Ohio State University, Columbus, Ohio.

Fig. 1.

AVERAGE WATTAGE OF ELECTRICAL APPLIANCES

1000 watts = 1 kilowatt

Appliance	Average Wattage	Appliance	Average Wattage
Bottle Warmer	400	Heat Lamp (Infrared)	250
Breiler	1325	Heater, Radiant	1095
Clothes Dryer	4600	Hot Plate	1165
Clock	2	Mixer, Food	130
Coffeemaker (Automatic)	830	Oil Burner	245
Cooker (egg)	520	Percolator	490
Dehumidifier	230	Radio	90
Dishwasher (With heat unit)	1155	Radio-Phonograph	100
Dishwasher (No heat unit)	290	Razor	15
Disposal (Only)	330	Sewing Machine	75
Fan, Attic	370	Stoker	300
Fan, Desk	70	Television	220
Fan, Furnace	225	Toaster	1000
Fan, Ventilating	85	Vacuum Cleaner (Tank type)	375
Floor Polisher	240	Vibrator	45
Germicidal Lamp	20	Waffle Iron	855
Grill	770	Washer	280
Hair Dryer	235	Water Pump	265

These appliances are usually controlled by thermostats which permit the flow of electricity for intermittent periods only.

Electric Blanket	180	Range	12,000*
Heating Pad	55	Refrigerator	205
Food Freezer (8 cu. ft.)	125	Room Cooler (Window type)	400
Iron	1,000	Roaster	1,300
Ironer	1,500	Water Heater (66 gallons)	3250

**This includes total wattage of all the burners and oven of the range.*

#4

Activity Title: "Energy Entertainment Survey"

Background: Teenagers and young adults are often abusers of entertainment devices. In one household as many as four or five devices may be operating at the same time.

Time Required: 30 minutes

Materials: Chalkboard

Procedure:

1. Copy the following form onto the chalkboard, using it to take a survey of the students in your class to determine the extent of their usage of entertainment devices.

Entertainment Device	Estimated Hours of Use Per Day	Estimated Hours of Use Per Week
Black and white TV		
Color TV		
Radio		
Tape player		
Stereo		
Electric Instrument		
Model Trains or cars (electric)		
Electric games		
Slide projector		
Movie projector		
		Total _____

2. From your survey calculate the average hours of operation for a year for one student.

To do this, take the total hours a week of those surveyed and divide by the number of students surveyed. This yields the average hours of operation of entertainment devices for one week. Then multiply by 52 weeks per year.

$$\frac{\text{Total hours per week}}{\text{Number of students surveyed}} = \text{average/week}$$

$$\text{average/week} \times 52 = \text{average/year}$$

3. Now use the total number of students in your school to estimate the total hours of operation of entertainment devices for one year.

$$\text{average/year} \times \text{number of students in your school} =$$

$$\text{operation per year of entertainment devices by your school's students}$$

4. Explain to students that Energy = Power x Time. One way to reduce consumption is to reduce the "time" factor.

5. Use an average power rating of .1 kilowatt (100 watts) to multiply the total number of hours the student body uses electricity for entertainment during one year. Multiply this product by \$.0362 to determine total cost.

$$\text{total hours} \times .1 \text{ kw} = \text{Kwh per year per student body}$$

$$\text{Kwh/year} \times \$.0362 = \text{annual cost of "electrical" entertainment}$$

Reference: Adapted from Energy Conservation in the Home, U.S. Dept. of Energy/University of Tennessee, 1977. pp. 220-221.

#5

Activity Title: "How Much Oil Does It Burn?"Background:

If one were to list all the energy-using appliances and equipment in his home, he would see why it is estimated that a well-equipped home consumes as much as 35,000,000 BTU's of energy each year (12¢ out of each energy dollar) to operate appliances and equipment. Much of this energy is wasted and offers a great opportunity for energy conservation.

The first step toward conservation is to gain a better perspective and understanding of each appliance's individual consumption. This is very easy to do. Find the electrical "ratings" information on the back or bottom of the appliance. You will see several numbers much like those shown below (from the base of a blender):

Model 850	U _L
Series	
Volts: 120	
Freq. 25-60 cycle	
Watts: 960	A.C. only JX

The key number is the wattage rating, 960 watts in the example above. The wattage is an indicator of the kilowatt-hours of energy used per hour of operation of the appliance. It requires 1 kilowatt-hour of energy per hour of operation for 1000 watts of power. In the example above:

Appliance: blender

$$\frac{960 \text{ watts}}{1000} = \frac{\text{watts}}{\text{kilowatt-hr per hour of operation}} = .96 \text{ kilowatt-hour}$$

Time Required: 30 minutes

Materials: Chalkboard, Assorted appliances borrowed from the Home Economics classroom, Overhead projector.

Procedure:

1. Make a transparency of Table 1.
2. Using 2 or 3 common appliances, compute the following on the chalkboard:

Appliance: _____

$$\frac{\text{_____ watts} \div 1000}{\text{_____ kwt-hr per hr of operation}} = \text{_____ kilowatt-hr.}$$

Appliance: _____

$$\frac{\text{_____ watts} \div 1000}{\text{_____ kwt-hr per hr of operation}} = \text{_____ kilowatt-hr.}$$

3. Using the Table 1 transparency, students can see what the appliances consume in equivalents of oil or coal per hour.

4. Discuss how collective electrical consumption habits have social and environmental impacts in areas far removed from the home.

5. (Optional) calculate the energy consumed in operating the overhead projector for this activity.

Reference: Adapted from Energy Conservation in the Home, U.S. Dept. of Energy/University of Tennessee, 1977. pp. 217-218.

Table 1.

Energy Conversion Table

Appliance Wattage Rating	Kilowatt-Hours of Energy Used per Hour	Ounces of oil Burned per Hour	Ounces of coal Burned per Hour
10	.01	.1	.13
25	.025	.25	.33
40	.04	.4	.5
60	.06	.6	.8
100	.1	1	1.33
150	.15	1.5	2
200	.2	2	2.66
300	.3	3	4
500	.5	5	6.66
750	.75	7.5	10
1000	1	10	13.33
1500	1.5	15	20
2000	2	20	26.66
5000	5	50	66.66
10000	10	100	133.33

SOCIAL STUDIES

DAY V ACTIVITIES

FUTURE ENERGY

You will need to choose one culminating activity from the following list.

Objective:

The student will understand the importance of adopting an energy conservation ethic compatible with future U.S. life styles.

#1

Activity Title: "The Good Life"

Background: Are the elements of the "good life", as recognized by most Americans now, compatible with a low-energy future?

Time Required: 15 minutes

Materials: Chalkboard

Procedure:

1. Ask the students to list characteristics of the "good life" as you list them on the chalkboard.
2. Which characteristics are dependent on a high-energy future?
Which are independent of energy?
3. Predict the kind of lifestyle which appears most compatible with a low-energy future.

Reference: Adapted from Energy Conservation, Energy & Man's Environment, 1977. p. 113.

#2

Activity Title: "Energy for Jobs"

Background: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

Time Required: 15 minutes

Materials: None

Procedure:

1. Ask students to write down on a piece of paper three vocational choices for their futures.
2. Specify that, in addition to availability of work in the vocational fields of choice, salary potential, required education and/or special training, attention should be given to the energy requirements associated with each vocational choice.
3. How would their vocations be affected if special forms of energy such as natural gas would be curtailed drastically? What would be the effects on those vocations if gasoline prices doubled? If electricity were to become much more expensive?
4. Ask that students consider also the ecological impact of their occupations on the local community, state, nation, and the world. Is the occupation likely to have a positive, neutral, or negative effect?

Reference: The Energy Book, South Carolina Department of Education, Columbia, South Carolina.

#3

Activity Title: "Futures"Background:

When we think about or plan for the future, we almost always expect to have as many material and energy-consuming goods as we desire. And we almost never believe that what we do as individuals will have any significant effect on energy consumption trends or proliferation of waste materials or on the amount of energy available. Individuals do have a significant impact on energy use. Forty-two percent of the energy used in Colorado is used in homes and for personal transportation.

Time Required: 15 minutes

Materials: Crayons, paper

Procedure: Encourage students to think about the future in terms of their own lifestyles and what impact future events will have on that lifestyle by asking them to:

1. Draw what they think they will be doing in the future (The Year 2000) and what their life will be like. Will they have a house? A car? Land? Will they have a family? What size? Where will they go on vacation? Encourage detail.

2. Now ask them to predict what they think the energy future will be like. More? Less? Different? In what ways? More or less expensive? Rationed? Have them compare their predictions of their future lifestyles with their predictions of the energy future. In what ways are they alike? Different? Do they expect that their individual future will be much more pleasant than society's future? What are some of their reasons?

Reference: Adapted from "Tomorrow Is Just Like Today?", Minnesota Dept. of Education, 1977.

APPENDIX

Parent Letter

Energy Fundamentals

Your School District

Your School Name

Date

Dear Parent:

During the next week we will be engaged in a cooperative effort with Colorado's Office of Energy Conservation to inform our students and their parents about household practices designed to reduce utility bills and to save energy.

Our students will be spending class time participating in activities related to household energy consumption and with associated homework assignments involving The Energy Scorecard. The latter is a home inventory or analysis of energy consumption patterns, designed to show the family how to reduce energy costs.

Your son/daughter will need your assistance in completing the various sections of the Scorecard. It is hoped that with a team effort, each family will better understand how to implement the simple, low-cost or no-cost techniques which can reduce household energy waste dramatically - saving you money in the process.

Sincerely,

Teacher

Class

ENERGY FUNDAMENTALS*

WHAT IS ENERGY?

Energy, though not easily defined, is quite noticeable. Man's senses respond to a variety of forms of energy. His eyes respond to light energy. His ears detect sound energy. Other nerves tell him when he is in contact with thermal and electrical forms of energy. These forms are interconnected and exchangeable. Different forms of energy can be used for the same purpose. Energy can be stored or transformed. Probably the most common and important characteristic of energy is its capacity for doing work.

Definition of Work

Work always involves overcoming some opposing force. Suppose that you must push a refrigerator from one side of the kitchen to the other. You must work against the frictional force between the refrigerator and the floor.

How is work measured? In the above example, the amount of work done depends upon the force exerted on the refrigerator and on how far the refrigerator is moved. That is, the work done is equal to the product of the displacement and the component of the force in the direction of the displacement.

$$\text{Work} = \text{force} \times \text{distance}$$

$$\text{or } w = fd,$$

where d (the distance of movement) is measured in meters and f (the applied force) is measured according to Newton's law of dynamics (that is, $f = Ma$). This unit of force is called the newton (n). Thus, the amount of work done is measured in newton-meters. When applied to work, newton-meters take the special name joule, named for the English physicist James Prescott Joule:

$$\text{one joule} = \text{one newton-meter}$$

* Adapted with permission from "Energy Basics", Energy Conservation in the Home, (Field Testing Draft), USDOE/University of Tennessee Environment Center, 1977. pp. 261 - 287.

Suppose that, instead of moving a refrigerator, you must lift a television. In this case, work is done against the gravitational force. How much work is done? Again, $w = fd$, but the magnitude of the force is the weight of the object, or $F = Ma$ where a is the acceleration due to gravity. Gravitational acceleration is usually indicated by the letter g . The weight or the gravitational force acting on the object is:

$$W = F_{\text{grav}} = Mg$$

On or near the surface of the earth, g has a value of 9.8 m/s^2 . The work required to lift a television (or any mass M) through a vertical height h can be written as:

$$w = F_{\text{grav}} d = Wh = Mgh$$

or the work done in raising an object is $w = Mgh$. If the television has a mass M of 10kg and the height it is raised is one meter (1m), the work done is:

$$\begin{aligned} w &= Mgh \\ &= (10\text{kg}) (9.8\text{m/s}^2) (1\text{m}) \\ &= 98 \text{ joules} \end{aligned}$$

One kilogram is equivalent to 2.2 pounds and one meter is slightly more than three feet.

Definition of Power

A definition of the term power is also necessary for a full understanding of energy. Power, like work, has a scientific meaning that differs from that used in ordinary conversation. When we say that a person has great power, we mean either great physical strength or great authority. But in physics, power means the time rate of doing work (using energy).

$$\text{Power} = \frac{\text{Work done (or energy used)}}{\text{time}}$$

$$P = \frac{W}{t}$$

When work is measured in joules and time is measured in seconds, power is expressed in watts; one joule per second equals one watt.

The watt is named after James Watt who designed the first practical steam engine. The watt may be used to express quantities of mechanical as well as electrical power.

Suppose that you must move an 10kg television a vertical height of one meter in two seconds. How much (average) power will be required?

$$\begin{aligned}
 p &= \frac{w}{t} = \frac{Mgh}{t} \\
 &= \frac{10\text{kg}(9.8\text{m/s})(1\text{m})}{2 \text{ sec}} \\
 &= \frac{98 \text{ joules}}{2 \text{ sec}} \\
 &= 49 \text{ watts (w)}
 \end{aligned}$$

For large amounts of power, the following designations are used:

$$1,000_w = 1 \text{ kilowatt} = 1\text{kw}$$

$$1,000,000_w = 1 \text{ megawatt} = 1\text{Mw}$$

The horsepower, defined in terms of the watt, is often used as a unit of measuring power:

$$1 \text{ hp} = 746 \text{ watts} = .75 \text{ kw}$$

Key Energy Laws

According to Einstein's equation, $E = mc^2$, energy and mass are inter-related. Mass may be converted into energy and energy may be converted into mass. Both types of conversion are constantly going on in the universe, but the total amount of energy and mass remains constant at all times. This fact is expressed in the Law of Conservation of Matter and Energy: the total amount of matter and energy in the universe remains constant. The conservation laws have been repeatedly proven in laboratory experiments and by countless observations.

When Watt developed his steam engine 200 years ago, he had little scientific and quantitative knowledge as to how the engine actually worked. During the first half of the nineteenth century, Joule, Carnot, and Clausius formulated the relationships among energy, heat, and work known as the laws of thermodynamics:

First Law: Energy and matter can be neither created nor destroyed.

Second Law: The energy content of the universe is constant, but the entropy of the universe increases toward a maximum.

Entropy is a measure of the unavailable energy in a thermodynamic system.

The importance of the laws of thermodynamics cannot be overstated. Their formulation meant that energy could be understood theoretically for the first time in history.

The first law (energy cannot be created or destroyed) says that "there is no such thing as a free lunch" or that "you can't get something for nothing." The second law says that "It's impossible to turn around and re-do something that has been done with the same energy that was used to do it in the first place. Once an act is accomplished, the energy required to accomplish it has degraded to a lower level, and becomes less available to do work.

Consider the following as an example of the Second Law. Natural gas is being used to heat a pan of water. The temperature of the gas flame is very high--several thousand degrees Fahrenheit. Some of the heat warms the water to 120°F from 60°F, and the rest of the heat is dissipated in the air, therefore making the air a little warmer. No energy is really lost in the process; it is simply dispersed from a state of high quality or availability to a state of low quality or availability. The Second Law says that whenever energy is used in a practical sense, it loses some of its quality. Highest quality sources should be used for highest quality needs; for example, high quality natural gas should be used whenever its high flame temperature and cleanliness are needed (bakeries need such a fuel). Likewise, it makes sense to heat water with solar heat rather than with natural gas.

Major Forms of Energy

In addition to energy contained in light, in molecules (like gas, oil, coal) and in atomic nuclei (like uranium), there are two major forms of energy: energy of position or configuration (potential energy) and energy of motion (kinetic energy).

Because potential energy can be converted into work, work units are used to measure and describe potential energy; that is, potential energy can be measured in joules. The potential energy (PE) of a mass (M), raised through a distance (h), where the acceleration due to gravity is (g), is:

$$PE = Mgh$$

The kind of potential energy described above is associated with the force of gravity. There are other kinds, associated with other forces. For example, a stretched rubber band has potential energy. So does an electric battery.

Every moving object has kinetic energy. For the purposes of "earth" physics, the earth is considered stationary, and an object resting on the surface of the earth is said to have zero kinetic energy. Kinetic energy depends on the mass as well as the speed of the moving object; the expression of kinetic energy (KE) of an object of mass (M) moving with a velocity (v) is:

$$KE = \frac{1}{2}Mv^2$$

Note that kinetic energy depends on the square of the object's velocity. As with potential energy and work, the unit for measuring kinetic energy is the joule.

Units and Conversion of Energy

Other units are commonly used to measure energy; for example, the kilowatt-hour is often used to measure electrical energy. One kilowatt-hour (kwh) is the amount of energy used to operate a 1,000-watt (one kilowatt) load for one hour. Recall that the kilowatt is a measure of power. The kilowatt-hour is a unit of energy that measures the work accomplished, or energy expended through the use of power over time:

$$\text{Power} = \frac{\text{Work done or energy used}}{\text{time}}$$

or

$$\text{Energy used} = \text{Power} \times \text{Time}$$

One kwh can be expressed in joules:

$$\begin{aligned} 1 \text{ kwh} &= P t = 1000 \text{ w} \times 1 \text{ hr.} \times 3600 \text{ sec/hr.} \\ &= (3.6)(10^6) \text{ watt seconds} \\ &= (3.6)(10^6) \text{ joules} \end{aligned}$$

The cost of one kilowatt-hour averages about 3.62¢ in Colorado. You might be surprised to learn how much work a kilowatt-hour will do. For instance, the work equivalent of one kilowatt-hour would lift a 10-foot cube of water about 40 feet!

Remember, kilowatts refer to power--the rate at which energy is used--and kilowatt-hours refer to the amount of energy used.

The calorie is used as a unit of energy in heat problems. One calorie is the amount of heat necessary to raise one gram of water one degree Celsius; one calorie is mechanically equivalent to 4.1860 joules. One thousand calories is a kilocalorie or k-calorie or Calorie--the familiar unit of food energy. The average American consumes 3,150 Calories of food energy each day.

The British thermal unit (Btu) is the amount of heat energy required to raise the temperature of one pound of water one degree Fahrenheit. The Btu is commonly used by engineers to specify the total amount of energy used for some specific purpose; for example, an air conditioner may have a cooling capacity of 8,000 Btu's per hour. The Btu is also used to specify the energy content of primary fuels or energy resources; for example:

Each gallon of gasoline has a heating value of about 136,000 Btu's. (Heating value is the maximum amount of energy released when fuel combines with oxygen in a combustion process.) If an automobile gets ten miles per gallon of gasoline, then it takes about 13,600 Btu's to drive the car each mile.

The following table relates the four basic units of energy:

Energy Conversion Factors	Value in joules	Value in Kilowatt-hours	Value in Btu's
1 joule	1	$(2.78)(10^{-7})$	$(0.95)(10^{-3})$
1 kilowatt-hour	$(3.6)(10^6)$	1	$(3.41)(10^3)$
1 Calorie	4186	$(1.16)(10^{-3})$	3.97
1 Btu	1055	$(2.93)(10^{-4})$	1

WHERE DOES ENERGY COME FROM?

As explained in the first sections, there are two major forms of energy--potential and kinetic--both of which manifest themselves in our lives in a variety of ways. Potential energy is always due to the presence of a force, and there are three basic types of forces in nature: gravitational, electrical, and nuclear. In addition to these three types of potential energy, it is convenient to discuss chemical energy as a separate form of potential energy though all forms of chemical energy are basically electrical in character.

Thermal energy is the kinetic energy associated with the motion of a material's interior particles. Two manifestations of kinetic energy are mechanical energy and sound energy. Material in this section presents an examination of the ways in which each form of energy can be converted into types of energy.

Types of Potential Energy

Gravitational Energy. Potential energy has been defined as that energy which a body has by virtue of its position in space.

Two natural energy resources can be harnessed for their gravitational potential energy: tides and rivers. When high tides go out, their gravitational potential energy is converted into kinetic energy which can be harnessed to create electrical energy. The tidal-powered electrical generating plant on the Rance River in France takes advantage of the power of the English Channel tides which rise as high as 44 feet. As the tide rises, gates are opened in the Rance Dam and water flows behind the dam to form a nine-square-mile pool. At high tide, the gates are closed. As the tide lowers, the trapped water is allowed to flow out, driving electricity-generating turbines. Similarly, the flowing water of rivers is frequently stored by hydroelectric facilities in reservoirs (dams). The stored water can later be released to turn the plant turbines which generate electricity.

Electrical Energy. All matter is composed of atoms, and each atom consists of protons, electrons, and (except for the simplest hydrogen atom) neutrons. An electron is a negative particle of electricity; a proton is a positive particle of electricity. These two kinds of particles are attracted to each other through the electric field which separates them. Electricity is a manifestation of either the separation of electrons from protons (static electricity) or the motion of electrons (current electricity).

There are two main kinds of current: direct and alternating. Work must be done to create either a direct or an alternating current in a circuit; in both cases, the energy expended comes from outside the system. Direct current often uses chemical energy to move electrons (voltaic cell) while alternating current uses the force of a rotating magnetic field to induce current. In both cases, the current can be used to perform work.

Although electricity is a form of energy, it is not a source of energy; rather, it serves as an energy transport system. Electricity is usually generated from the following sources: petroleum, natural gas, coal, hydro power, or nuclear power.

Chemical Energy. Substances can be said to store chemical energy in the sense that when they enter into a chemical reaction with oxygen (a process known as oxidation) to form a new chemical compound, they release heat or cause electricity to flow. For example, when wood burns, it combines with oxygen and gives off heat; or when gasoline burns, the potential chemical energy in the gasoline is released as heat energy. Other sources of chemical energy besides natural gas and wood are coal and petroleum (also fossil fuels) and storage batteries.

Natural gas is primarily composed of the fuel, methane. When methane burns, its reaction with oxygen produces carbon dioxide, water, and energy. Specifically, 55,000 joules of energy are released by one gram of methane when it is burned. For the reaction to occur, several atomic bonds must be broken and new ones formed. Since methane and oxygen together have more electrical potential energy than carbon dioxide and water, the oxidation of methane releases energy.

Nuclear Energy. The release of chemical energy involves the rearrangement of molecules. Similarly, the release of nuclear energy involves the rearrangement of neutrons and protons to form different nuclei (the core) within individual atoms. There are two types of nuclear energy: fission and fusion. Fission occurs when the nucleus of an atom splits into two parts. When a neutron hits an atom of a fissionable (splittable) element, it may be captured by the atom's nucleus. If it is, the atom may split into two smaller atoms, each having approximately half the mass of the original atom. The original atom releases two or three neutrons which may then hit other atoms and cause them to split. Thus, a chain reaction may occur. Radiant (light) energy is also released during the fission process.

Fusion occurs when two lightweight atomic nuclei unite to form a heavier nucleus. A fusion reaction is also called a thermonuclear reaction because it takes place only at extremely high temperatures. At the present time, man does not know how to make hydrogen atoms fuse in a useful way (other than in an explosion) because a method to contain the extreme temperatures needed has not been found. Hydrogen fusion could be a useful energy alternative because its fuel comes from water (deuterium). Unlike fission, hydrogen fusion would produce much less radioactive waste.

Thermal Energy: The Bridge Between Potential and Kinetic Energy

As indicated earlier, thermal energy is the total potential and kinetic energy associated with the random motion of a substance's particles. The quantity of thermal energy possessed by a body determines its temperature. But the same quantity of thermal energy possessed by different bodies does not give both the same temperature. The relation between thermal energy and temperature depends on the particular substance. If the average kinetic energy (a part of the total thermal energy) of a substance's particles is increased, the temperature of the substance is increased. If the average kinetic energy is decreased, the temperature goes down. If we were able to cool a body to the point where all thermal motion ceased, the temperature would be called "absolute zero."

Most substances have three phases or states: solid, liquid, and gas. The change of phase from a liquid to a solid is called fusion. (Do not confuse this term with nuclear fusion.) Energy must be supplied to a body undergoing fusion in order to increase the potential energy of the solid's particles, or appears as work done on the particles in changing from a solid structure to a liquid "structure." Fusion is a constant temperature process; as the solid melts, the potential (not kinetic) energy of the substance increases. For example, when the appropriate amount of energy is supplied to ice without a change in average kinetic energy, the particles of the ice increase in potential energy without a change in temperature and the ice melts to form water; the energy enables the particles in the water molecules to overcome the forces that hold them in fixed positions. The energy added to any substance to make it melt increases the thermal energy of its molecules.

Similarly, when an appropriate amount of energy is supplied to a liquid without a change in kinetic energy, the liquid increases in thermal energy and becomes a vapor without a change in temperature; that is, liquid particles become particles in the vapor phase. Vapor is the term used to describe a liquid that is in the gaseous phase. When vaporization occurs from liquids, it is called evaporation. Sometimes a direct change from solid to vapor occurs; this change is known as sublimation. When a substance undergoes vaporization, the energy supplied gives the particles of the liquid sufficient thermal energy to overcome the forces binding them to the liquid, and enables them to separate from each other and move among the molecules of the gases above the liquid. The energy required to vaporize a unit mass of liquid at its boiling point is called its heat of vaporization.

The terms temperature and heat are often confused. Temperature is a physical quantity that is proportional to the average kinetic energy of the molecules in a substance. Heat involves the transfer of thermal energy from one body to another of lower temperature. Boiling water always has approximately the same temperature, but the amount of heat in boiling water depends on the amount of boiling water; a small pot of boiling water contains less heat than a large pan of boiling water, though their temperatures are the same. All substances have thermal energy, but all substances are not sources of heat energy. The amount of heat energy in a substance depends upon the total amount of thermal energy it has in relation to other substances. It is possible for a substance to have a low temperature, yet produce a lot of heat; for example, a radiator gives off more heat than a burning match even though the radiator is at a lower temperature than the flame of the match.

Types of Kinetic Energy

As indicated earlier in this section, there are three major types of kinetic energy: mechanical, sound, and radiant. It should be added that there are other manifestations of kinetic energy, such as a running horse, or any human movement. Three major types of kinetic energy which have significant impacts on our lifestyles are discussed below.

Mechanical energy is found in machines. In ordinary language, the term machine refers to any mechanical device that is used to accomplish a chore faster or more conveniently than it could be done without a machine.

One must keep in mind that although machines are generally associated with kinetic energy, machines are constantly involved in an interplay of kinetic and potential energy. The interplay of kinetic and potential energy in machines is known in physics as the law of conservation of mechanical energy. This law states that the sum of the potential and kinetic energy of an ideal energy system (an ideal machine) remains constant. Of course, there are no ideal machines. All machines are hindered by dissipative forces such as friction (which produces heat rather than mechanical energy). But this heat energy is not "lost" in the real sense; the laws of thermodynamics say that there is a constant amount of energy in the universe--energy may be converted into another form, but is never lost.

Because of the presence of dissipative forces, no machine is 100 percent efficient. The ratio of the useful work output of a machine to the total work input is called its efficiency:

$$\text{Efficiency} = \frac{\text{Work Output}}{\text{Work Input}}$$

Sound Energy. Like heat energy and electric energy, sound energy is a method of energy transfer. Sound may be generally defined as the result of a

series of wave disturbances traveling from a source through a medium (usually the atmosphere) to the human ear. Wave disturbances also occur at levels above and below the wave frequencies to which the human ear is sensitive. The range of audible frequencies compose the audio spectrum, while those above and below this range compose the ultrasonic and infrasonic spectrums. The three spectrums together are known as the sonic spectrum.

Radiant energy is the result of electromagnetic disturbances or waves. The electromagnetic theory says that the various phenomena of radiation are caused by electromagnetic waves whose energy is divided between an electric field and a magnetic field--both of which are perpendicular to each other and to the direction in which the waves move. Unlike sound energy, radiant energy does not require a medium to be carried through space; radiant energy can travel freely through space.

Light may be defined as the electromagnetic energy that a human body can detect. The optical spectrum consists of light energy--a small part of all radiant energy.

Energy Conversion

Energy conversion means changing one form of energy into another. For example, when we switch on a vacuum cleaner, electrical energy is converted into mechanical energy. The series of conversions which concurrently take place in the conversion of nuclear energy from the sun to electrical energy is a more complex example. Nuclear fusion reactions in the sun produce radiant energy which causes water on the earth to evaporate and winds carry the vapor over land. The evaporated water eventually condenses to form clouds which may then condense further to form rain. The rain may fall into a river which flows past a hydroelectric plant; the gravitational potential energy of the river is turned into electricity at the hydroelectric plant. The electricity may then be used to produce mechanical energy (e.g., to power a saw) or it may be stored as chemical energy.

The series of energy conversions in a steam generating plant are shown in simplified form in the following diagram:

Fossil Fuel----->Boiler----->Turbine----->Generator
 Chemical Energy--->Heat Energy--->Mechanical Energy--->Electric Energy

Coal, oil, and natural gas are the fuels used in most steam generating plants. Recall that all three fossil fuels contain chemical energy. The coal is loaded into a furnace. While it burns, it releases heat energy which sets water boiling and subsequently changes it into steam. The steam then flows through large pipes to the steam turbine where it turns the blades of the turbine to produce mechanical energy in the form of a rotating shaft. Recall that some mechanical energy is always dissipated by friction. The rotating shaft drives an electric generator to producing electricity. Nuclear energy can also be used to produce steam and now accounts for almost thirteen percent of all U.S. electricity generation.

HOW IS ENERGY TRANSPORTED AND STORED?

Energy Resource Transportation Options

There are five basic ways to transport energy: water, rail, highway, pipeline, and powerline. The method used depends upon the particular energy resource and the location of the resource. This decision may be influenced further by the energy intensiveness of each mode; that is, the method used depends upon how much energy is used in each mode of transportation. The following table shows the energy intensiveness of each mode of energy resource transport (except powerlines--electricity cannot be effectively measured in tons) in 1970:

Energy Transport Mode	Energy intensiveness, expressed in Btus of energy needed to move 1 ton of freight 1 mile
Truck	2,800
Waterway	680
Railroad	670
Pipeline	450

Clearly, truck transport is less energy-efficient than pipeline transport because trucks use more BTUs to move one ton than pipelines does. Thus, if you had a choice between shipping petroleum by truck or by pipeline and your only criterion for choice was minimum energy, you would transport it by pipeline: fewer Btu's of energy consumed during transport usually means a lower transportation cost. Electricity (secondary energy) is very costly to transmit, even at high voltages. Furthermore, on the average, 10 percent of all electric energy may be lost through transmission and distribution inefficiencies. It also takes energy to move oil and gas through pipelines, but much less than electricity. On the other hand, electricity is relatively cheap to generate; the transmission and generation costs are about equal.

The cost of each mode of transportation is important; for example, the transport cost may determine whether you heat your home by natural gas, oil, or electricity. Part of the cost is due to the cost of the transmission wire. Also, the cost depends on the voltage of the electricity transmitted. The higher the voltage, the less it costs to transmit the electricity. Unlike pipeline transmission, electrical transmission and distribution systems allow the energy to be drawn upon for all markets along the way. While powerlines are unsightly, they do not pollute as pipelines do when they break, and although powerlines lose about 10 percent of the electrical energy they carry through transmission and distribution inefficiencies, powerlines are the fastest growing energy transport method.

Energy Resource Storage

Whenever possible, energy is stored for future use. The type of energy storage used depends upon the particular energy resource. This section discusses the ways in which fossil fuels, water, electrical energy (in the form of chemical energy), and mechanical energy are stored.

Fossil Fuels. After coal is removed from the mine, it is transported to a power plant, coke-oven, or some other type of coal-processing operation. It is then stockpiled in the open air. Unfortunately, this is not an efficient storage method; oxygen causes coal to deteriorate. But coal is so bulky and heavy that it cannot be stored otherwise. Since the early 1960's, until trains, which travel non-stop from the mine to the coal-processing operation, have lessened the need for huge stockpiles; a large amount of coal can now quickly reach power plants in periods of peak energy demand.

During the winter, residential consumers use approximately five times as much natural gas as in the summer. The distribution utilities, therefore, contact natural gas companies for sufficient gas to meet peak demand days and dispose of excess "summer gas" to industrial consumers, unless this excess can be stored underground.

In 1970 there were 325 underground storage pools with a total estimated ultimate capacity of approximately 5.2 trillion cubic feet of natural gas. Most of these storage areas were originally gas-producing pools which had been converted to natural gas storage areas. The rest were converted from combination oil and gas pools, oil pools, coal mines, salt storages, and aquifer reservoirs (water-bearing beds).

Crude oil is stored either in pipelines or in large storage areas, usually tanks until it is needed for refining. The huge floating concrete storage tank at the Ekofisk production center in the North Sea holds one million barrels of oil. Outer Continental Shelf (OCS) oil is stored on the ocean floor by some countries. It is anticipated that the U.S. will develop this type of storage as OCS drilling moves greater distances from the U.S. shores. Domestic supplies are refined and then once again are stored in tanks - on the shore or miles inland--or in underground pipeline systems. Foreign supplies of crude oil are transported to the U.S. by supertanker. An undersea or underground pipeline takes the oil to storage tanks on the mainland where it is refined and stored again.

Water. Two types of water storage are used to create hydroelectric energy: gravity water storage and pumped water storage.

Rivers are natural energy resources that can be harnessed for their gravitational potential energy. The potential energy in the water was supplied by solar power, which earlier evaporated the water and transported it to the higher elevation. Gravity water storage is used to collect and hold a river at high elevations so that the potential energy available from the river can be converted to electric energy during peak electrical demand periods.

The actual flow of a river at a given time cannot be predicted. But the annual flow can be predicted accurately enough to determine the optimum power plant size, reservoir volume, and operating schedule for the most efficient use of the river's gravitational potential energy.

Water storage which involves the pumping of water rather than the flow of a river is called pumped water storage. The simplest pumped water storage system uses energy from a thermal plant to pump water from one reservoir to a higher one. At a later selected time, gravity causes the water to flow back to the lower reservoir, and electricity is generated. Pumped water storage systems are usually used in conjunction with gravity water storage systems. Many pumped water systems make use of some natural river flow; that is, river water flows into the higher reservoir and water is pumped to the higher reservoir from the lower reservoir. Less water is pumped than is used for generating purposes.

The advantage of the pumped water system is that during periods of low electricity demand the thermal plant can consistently use the power it generates to pump water to the higher storage area. Then, during periods of peak demand, energy from the thermal plant and the pumped storage plant can be utilized to meet peak demand. Thus, the thermal plants can be efficiently operated continuously at full load and, consequently, energy for peak demand periods is obtained at low cost. However, energy is lost in using pumped storage, due to the fact that the electric motors used to pump the water and the turbine-generators used to reconvert to electricity are not 100% efficient. Typically, 30 percent or more of the energy is lost in this process.

Electrical Energy. Batteries are used to store small quantities of direct current electrical energy in the form of chemical energy. The high capital cost of batteries and AC/DC/AC conversion equipment make battery energy storage impractical where large amounts of energy are concerned.

Four types of batteries are common: lead-acid, nickel-cadmium, zinc-silver, and nickel-iron. The type of battery used depends upon the particular application; for example, when high discharge rates are needed to power an external load, zinc-silver batteries are used. On the other hand, moderate discharge rates are provided by low-cost lead-acid batteries; they are the most commonly used type. Minimum gas generation is provided by nickel-cadmium batteries, and ruggedness is provided by nickel-iron batteries.

Mechanical Energy. The principle of a flywheel is that a spinning wheel, by its inertia, stores mechanical energy; that is, just as water can be put into and taken out of a reservoir, energy can be put into and taken out of a revolving wheel (flywheel). The earliest flywheel was the Urkusk potter's wheel of 6500 years ago. During the Industrial Revolution, flywheels were used to oppose and moderate any fluctuation of speed in the steam engines that powered mills and factories. Today, flywheels carry the rotation of pulses of mechanical energy delivered by the pistons of internal-combustion engines.

RENEWABLE AND NONRENEWABLE ENERGY RESOURCES: THEIR FUTURE AVAILABILITY

All energy resources belong to one of two groups--renewable or nonrenewable resources. Nondepletable energy resources are renewable; for example, the sun is a renewable resource, as is water. In 1974, only six percent of all energy resources consumed were renewable.

Depletable energy resources are nonrenewable. Fossil fuels--coal, oil, and gas--are nonrenewable because they were produced over millions of years by vegetation under pressure in the earth's crust and heated by the sun. Uranium, another important energy resource, is also nonrenewable. In 1974, 94 percent of all energy resources consumed were nonrenewable; in other words, America's high-energy society is based upon a finite, dwindling supply of energy fuels.

Renewable Energy Resources

Solar. By 1973 only a few dozen U.S. homes had been constructed with solar heating systems; but by the year 2000 solar heating and cooling could satisfy perhaps 10-20% the needs of all new residential and commercial buildings. Presently there are some very promising approaches to using solar energy for low temperature needs such as space and water heating, but the cost is still relatively high (\$20 to \$25 per square foot for solar panels) and functional storage systems must be developed to operate in conjunction with the solar devices. If solar equipment (lenses, mirrors, panels, and other devices used to concentrate the energy of the sun) can be made cheaply enough, we could produce electricity either by a thermal cycle (making steam and driving a turbine) or by direct conversion using solar cells. The thermal cycle alternative is much closer to practical implementation, but is still several times as expensive as present methods of energy generation.

Geothermal. Large amounts of geothermal energy (heat in the form of steam, such as that found in geysers) are present in the earth's crust, but it is possible to tap these resources only in limited locations. Thus far, development and exploration in the U.S. has been conducted mainly in the West (California) because the most promising sites are found there. Experts estimate, however, that over the next 25 years as much as 25,000 MW will be provided by geothermal plants, where steam from the earth is used to drive turbines which generate electricity. There are, however, a number of disadvantages to using geothermal energy in this manner. Equipment used in the plants tends to corrode quickly because of minerals which dissolve in the hot water. These same minerals can create some environmental problems in the form of ground water contamination, waste salts, and air pollution (including escaping hydrogen sulfide which smells like rotten eggs). Finally, geothermal steam is not very hot, and so is an inefficient means of producing electricity (it also produces a lot of "waste heat").

Wind. Like geothermal energy, practical wind energy is found only in certain locations, mostly in the Midwest and Northeast. Even there, it is variable and must be accompanied by storage devices or used only for special purposes, such as pumping water for stock ponds. At present, however, wind power generators are being tested in Northern Europe, Russia, and the U.S. Unless research designers prove otherwise, many windmills are needed to obtain a reasonable quantity of energy (thousands would be needed to equal the output of a single modern electric generating plant).

Tides. Although suggestions have been made to harness the energy in tides, the total amount of tidal energy potential ($2 \cdot 10^6$ MW) would make a negligible impact on the world's energy supply. Furthermore, suitable locations are not where the demand is and severe environmental problems could be caused by massive movements of water in and out of coastal areas. Other disadvantages are visual pollution if the generating facilities were in a resort area, corrosion of equipment by salt water, and high capital costs.

Wood. Wood is still an important energy source in "third world" nations and can provide a great deal of power for short periods. Wood could continue to be used as a renewable fuel if it were grown on "plantations" and then burned to produce electricity. The obvious disadvantage, however, is the competition for land use by the agricultural sector.

Hydro (Water). Most hydroelectric potential in the United States is already being used and environmental problems will probably prevent the development of additional sites. By the year 2000, it is estimated that it will provide 125,000 MW of power, but only 10 percent of the nation's electricity demand. Much of the capacity in 2000 will be used for pumped storage systems which will use the spare capacity of "base load" electric plants (for example, in the middle of the night) to provide power during periods of peak demand the next day. Water will be pumped uphill for storage, and power will be produced later when it is released downhill.

Fusion. The key concepts and technologies which may unlock the intricacies of fusion are not yet known. If developed, fusion could provide a long-range solution to the world's energy shortages because a nearly inexhaustible supply of deuterium (the fuel necessary to produce fusion power) is found in water.

Refuse. Using our solid wastes to supply part of our electrical demand is an idea which appeals to many people and, indeed, some small plants are already in operation or under construction which can produce electricity from solid wastes. One such plant in St. Louis burns approximately 300 tons of municipal waste per day to generate 12.5 MW of electricity. But even if we took full advantage of the energy contained in all refuse, less than 10 percent of our energy needs would be met.

Nonrenewable Energy Resources

Coal. Coal is the only nonrenewable energy resource which still exists in relatively great abundance. Proved U.S. reserves are estimated to be 400 billion tons; possible resources are estimated as high as 3200 billion tons. This adds up to as much as 200 years' supply of coal at the current energy use rate. Coal is presently used to convert water to electricity or to make steam for industry, in the future it may be converted directly to gas or oil. Coal creates many environmental problems, however. Because it is a "dirty" fuel, it causes air pollution (the higher the sulphur content, the more pollution; western coal has less sulphur, but more ash, than eastern coal). Strip-mining--the easiest and least dangerous method of coal mining--causes erosion and leaches wastes into streams and watersheds. Companies which strip-mine for coal (about half of all U.S. coal is strip-mined) are being pressured to reclaim stripped land at high cost.

Natural Gas. The proved reserves of natural gas are close to 200 trillion cubic feet. At current energy use rates, this supply would last only eleven more years. Estimates of possible additional resources range from 450 to 2,000 trillion cubic feet--a current use rate range of 20 to 100 years. At the present time, natural gas is our least expensive fossil fuel because of price controls that make it artificially cheap. In the future, however, the price of natural gas will become much higher, necessitating many current users to switch since natural gas is the cleanest of the three fossil fuels and is in great demand for space heating.

Oil. The amount of oil which remains in the U.S. and off-shore is unknown, though proved reserves (including Alaska) are estimated to be 45 billion barrels (BBL) and estimates of possible reserves are in the neighborhood average 89 BBL. At current consumption rates, this supply would last only nine more years. Like that of natural gas, the price of extracting petroleum from U.S. oil fields may become so high that we will change our present use patterns. Costs will increase because most of the easy-to-get oil has been consumed and new harder-to-get sources requiring more complicated technologies will have to be tapped. Exploration for additional oil reserves centers on sites under as much as 800 feet of ocean or as far as 25,000 feet underground. Other large reserves of oil are trapped in fine-grained rock called shale. Useful fuel can be extracted from oil shale, but the net energy produced may be small, the process expensive (perhaps twice the present cost), and the environmental problems significant (large amounts of water are needed for extracting processes.)

Uranium. Uranium, as a fuel for nuclear reactors, is a controversial energy source. It is highly favored by some groups because the potential energy of a given quantity of uranium is several million times greater than the energy available from an equal quantity of any one of the three fossil fuels. Mining uranium is a great deal more difficult than fossil fuels, however. Even the richest uranium ore may contain only a fraction of one percent of uranium. Because uranium ore is not pure and the costs of extraction vary, the amount of

current reserves are hard to estimate. It has been suggested, though, that we only have 30 years worth left of U^{235} --the uranium necessary to produce fission reactions in conventional nuclear power plants. The drawbacks to fission as it is presently used to produce electricity are the radioactive wastes and safety concerns. These objections may be overcome with the possible future development of the breeder reactor. At the present time, breeder technology is not well-established; costs of development will be high, and it is known that the waste product--plutonium--is extremely toxic. If breeders can be successfully developed and these obstacles overcome, the effective amount of fissionable material (the plentiful U^{238} after being converted to Pu^{239}) is tremendously increased, making our current energy reserves of uranium large enough to fulfill our energy needs for decades.